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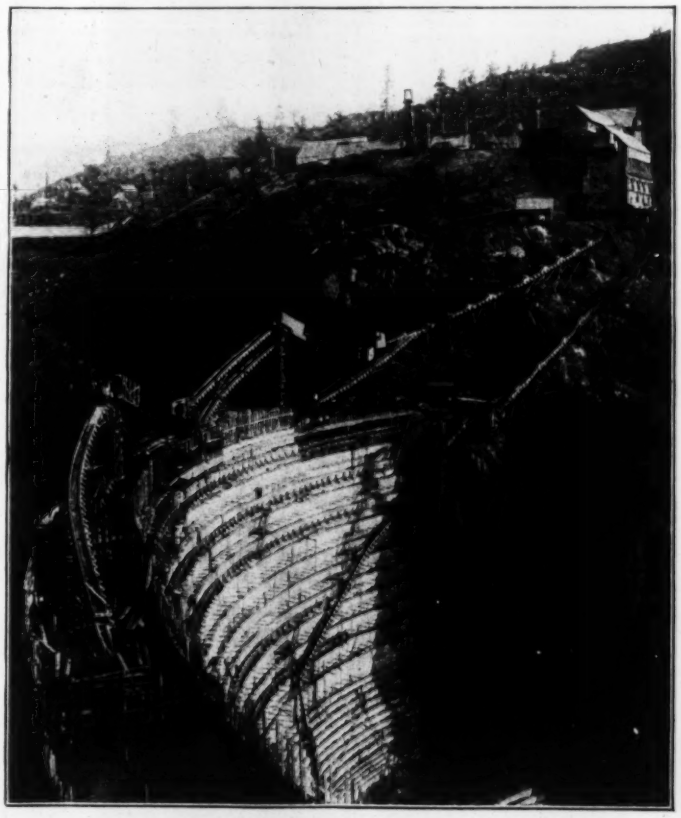
Concreting the Spaulding Dam

The Spaulding Dam in the South Yuba power development of the Pacific Gas & Electric Co., in Nevada County, Calif., is one of the largest and highest dams in the world. It is arched in plan, 305 ft. high and is of concrete deposited in mass. As described in ENGINEERING NEWS, Dec. 11, 1913, p. 1163, the concrete was mixed in a plant high up on the side of the cañon and chuted directly into place for the lower levels, belt conveyors being used to lift the concrete high enough to chute it into the upper levels. At the time of the previous article, however, construction had not progressed so far as to show the final stage of the conveying plant illustrated in the accompanying view.

The mixer house was built at the rim of the cañon, as high as was consistent with locating it close to the spur track over which cement, gravel and sand for the construction were hauled. These materials were transferred to the mixer house on 18- and 24-in. belt conveyors. The mixing-plant equipment consisted of four 1-yd. Smith mixers, with a combined capacity of 2000 cu.yd. in 24 hr. From the mixers wooden chutes 2½ ft. deep and 2 ft. wide, lined on the bottom with cast-iron plates and on the side with sheet steel and laid at an average incline of 25°, conveyed the concrete into place.

When the dam had been constructed to a height of approximately 225 ft. the above-described method of distribution became impracticable, as the slope of the chutes could not be made steep enough for the concrete to flow. Two vertical steel frames were then erected, their bases being firmly embedded in the concrete. They were designed to support two inclined steel frames (shown in the view sloping up away from the far side of the cañon), equipped with belt conveyors. The concrete was then elevated in two stages for the more remote portions of the structure and in one stage for parts at the center of the dam nearer the mixer. In the view, the chute in the nearest part of the dam is depositing concrete that has been chuted down from the mixer, raised by belt conveyor to the top of the far tower, chuted down to the conveyor leading to the top of the near tower, whence it descends through the final chute.



DEPOSITING CONCRETE BY CHUTE AND BELT CONVEYOR, SPAULDING DAM, CALIFORNIA

It is stated that the chutes required very little attention for operation except when it was necessary to change their location; they therefore gave a most economical system of conveying concrete. One novel feature was the method used for cleaning the belt conveyors. In the past, with belt systems of distribution for mixed concrete, the chief difficulty seems to have been in keeping the belt clean and free from concrete material caking upon it. This difficulty was overcome in the Spaulding plant by the use of compressed air. Just beneath the belt at the point where it passed back under the last roller, jets of air were forced against the belt from fan-shaped nozzles. These delivered the air at a pressure sufficient to remove all material adhering to the belt. This device kept the belt smooth, clean and in good working order, although without it the concrete soon put the belt out of commission.

In the earlier part of the work, when only gravity distribution was used, the record of concrete laid was as high as 2150 cu.yd. in a 10-hr. day. After the intermediate belt conveyors were installed the record was about 2000 cu.yd. per 10-hr. day delivered on a 24-in. belt traveling 400 ft. per min.

Placing the Milwaukee Water-Works Intake Crib

By Roland E. Stoelting*

The new Linwood Ave. intake tunnel for the water-works at Milwaukee, Wis. (see Engineering News, June 18, 1914), will end at a shaft 4000 ft. from shore, rising to a crib from which 6-ft. pipe lines will extend about 1500 ft. to submerged intakes in 60 ft. of water.

The crib is a steel structure 60 ft. in diameter and about 60 ft. high. It has an inner shell 19 ft. in diameter

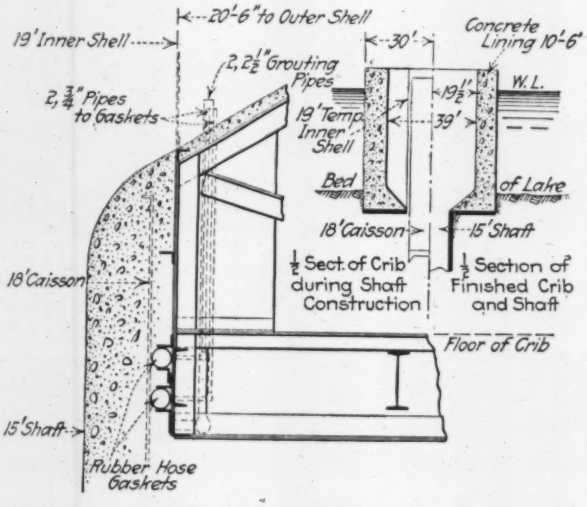


Fig. 1. The New Water-Works Intake Crib, Milwaukee, Wis.

for use during the sinking of the shaft, which will be removed later. The completed crib will have a concrete lining 10½ ft. thick and an interior diameter of 39 ft., as shown in Fig. 1. In the annular space, 20½ ft. wide, are eight vertical radial trusses and four vertical radial partitions. The latter form four separate compartments which could be filled with water through small gate valves to keep the crib level while being concreted, and which also permitted the use of water as ballast in case of storm during the work. Cast-iron blank flanges are bolted to the four pipe inlets, to be removed when the intake pipes are installed. The lining has been built against the outer shell and about 12 ft. of concrete placed in the bottom of the crib.

The first 18 ft. of the steel crib was erected at a municipal dock on the Kinnickinnic River. It was supported on four oak timbers, at right angles to the dock line, carefully blocked up and set on an incline of approximately 1 to 8½. At the dock line the tops of the timbers were about two feet above the water. The steel-plate sections forming the bottom of the crib were assembled on this timber work and riveted together. The floor system and vertical-truss supports were then set in place, followed by the first ring of plates of the outer shell. Considerable additional blocking was then placed and the crib was pumped full of water so as to determine its water-tight condition.

Asbestos strips had been used at all the joints, and the crib was thoroughly water-tight except in a few places where the asbestos had been unavoidably moved out of place while some of the larger vertical plates were being erected. This compelled some additional calking along the vertical plates. The inner shell had bolted joints. The plates composing the bottom fitted accurately, and their joints were all water-tight.

On June 29 the crib was launched (Fig. 2). All blocking excepting that under the ways had previously been removed. Although the ways were well greased, a little assistance by a tug was necessary to start the crib. When launched it remained water-tight. It was moored alongside the dock while the remaining steelwork (except the roof) was placed, the crib being revolved so that all this could be done with the aid of a long-boom derrick on the dock.

This part of the work was completed in a comparatively short time, and the contractor commenced placing concrete in the bottom of the crib. The derrick was used for this until the crib drew about 10 ft. of water, when it was towed out to the Government breakwater, where the water

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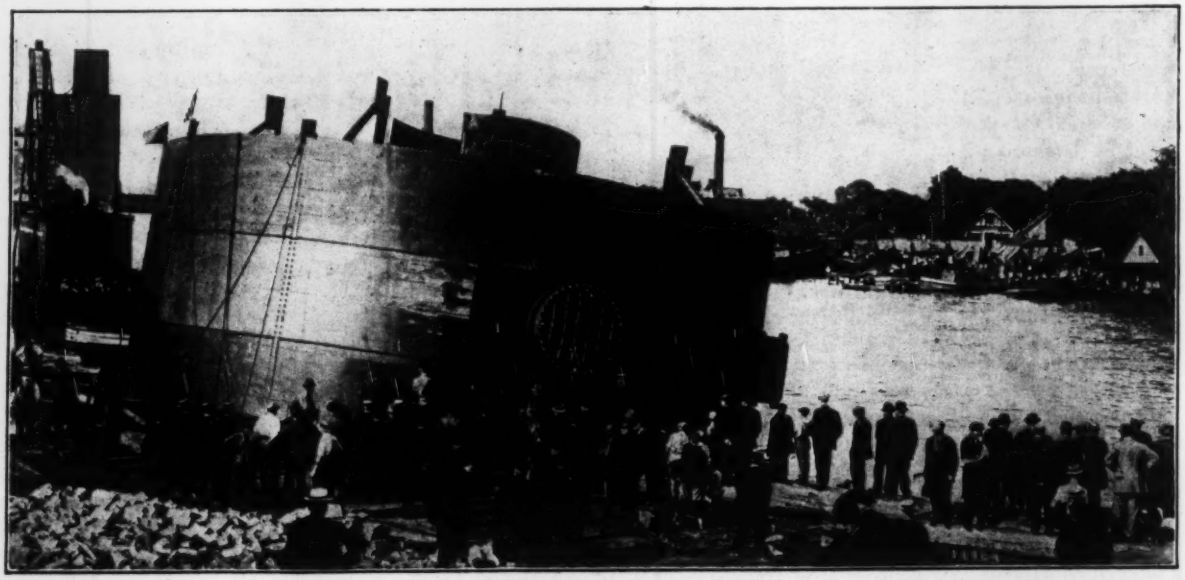


Fig. 2. Launching the Milwaukee Water-Works Crib

is 40 ft. deep. Here the concrete was placed until the crib drew about 38 ft. of water. A derrick installed on an old schooner, rigged up for the purpose, was employed to place this concrete.

In the meantime the contractor was leveling off the lake bottom at the site for the crib, which took much longer than was anticipated. The bottom at this point is mostly hardpan and required considerable blasting so that it could be dredged. Charges of dynamite were placed by a diver and fired electrically from a tug. The exact points for excavation were indicated by means of buoys. The space excavated was 100 ft. square, with a maximum depth of excavation of about 5 ft. The weather conditions were so unfavorable during the summer of 1914 that there were not many days when this kind of work could be carried on.

Four large anchors were placed some distance outside of the excavation, to control the location of the crib. The

FIG. 3. THE NEW CRIB SUNK IN PLACE

work was completed on Sept. 20, and the crib was towed out to the site and secured to the anchors, two of which were on the line of the tunnel and two at approximately right angles thereto. Two buoys placed on lines at right angles to the tunnel were used to locate the crib as nearly as possible in the center of the excavation, the tunnel line being given by a transit on shore.

After the crib was moored in position, the four small valves in the inner cylinder were opened, thus permitting water to flow into the four compartments of the annular chamber. While the crib slowly sank the men handling the anchor lines kept it over the center line of the tunnel, as directed by signals from the instrument-man on shore. In this way it was placed within a few inches of the exact location intended. When it rested on the bottom of the lake it was allowed to fill with water, and was weighted down with crushed stone placed on a temporary platform which extended over the greater part of the crib. The stone was placed in a short time by means of an endless conveyor from a large steamer.

The remaining concrete was placed through iron spouts which conducted it to the various compartments. A mixer and a steam derrick were installed on a temporary platform on the crib, so that they could be shifted from time to time. The material was delivered directly to the mixer from a scow which was moored alongside (weather permitting). The concrete was conveyed to the various spouts in a 1-yd. bucket by the derrick.

An attempt was made in the beginning to place this concrete under water by keeping the spout filled and its lower end constantly embedded in the fresh concrete. This had to be abandoned after a few days because the contractor could not handle the spouts properly with the equipment at hand. The crushed-stone ballast on the temporary platform provided sufficient weight to permit of pumping out the water, and the concrete was then placed in the dry.

A considerable bulk was placed in a single section before the mixer and derrick were shifted. The progress made was slow, but in this manner the remainder of the concrete was placed to within a few feet of the top of the crib, when the work was discontinued owing to the lateness of the season. The steel roof trusses, crib light and fog signal were then placed temporarily on the crib, as shown in Fig. 3, to remain in place until the working season of 1915, when they will be removed so that the lake shaft can be sunk.

The shaft is to be constructed by sinking a caisson through the 19-ft. inner cylinder of the crib. This caisson is to be made in sections 8 ft. high and 18 ft. diameter, securely bolted together, and will extend from above the water level down through the lake bottom.

The sinking of this caisson forms a part of a separate contract, but provision was made for a water-tight connection between the caisson and the inner cylinder of the crib. Two sets of angle irons have been placed around this cylinder, near the bottom, which are to partly inclose two rubber-hose gaskets, as shown in Fig. 1. When the caisson has been sunk to the required depth, the gaskets are to be inflated with air or water. The space below can then be filled with concrete grout. All that portion of the caisson above the gaskets will be removed, as well as the inner cylinder of the crib, and a substantial connection made by carrying up the shaft lining to meet the inside of the bottom of the crib.

Gate chambers have been provided in the concrete lining for the gates which are to control the water from the four pipe lines. After the shaft is completed, the valves are to be installed, the pipe-line specials placed in position and the roof on the crib completed.

The crib is to be protected at night by an acetylene-gas beacon light equipped with an automatic sun valve. The light flashes every three seconds and will operate a year without attention. At present a bell is used as a fog signal, operated electrically by storage batteries and controlled by a delicate hair hygrometer so that it rings only during periods of high humidity. The storage batteries are charged once a month. When the new intake is in operation, a bell will be rung continuously by power derived from the water flowing through the crib.

The Wisconsin Dredge & Dock Co. has the contract for the crib, and the Wisconsin Bridge & Iron Co. furnished the steel. The work was done under the supervision of Geo. F. Staal, City Engineer. The writer was resident engineer on the construction of the crib and was intimately associated with its design.

A New Road to the Yosemite National Park, running from western Nevada, is to be built by the Federal Government. The old Tioga road, from Mono Lake on the east slope of the Sierra Nevada across the Yosemite National Park to the village of Sequoia, has been purchased by public subscriptions in California and turned over to the United States government. Secretary Lane on Apr. 19 stated that the road would at once be rebuilt and put in shape for motor traffic early in July. The road skirts the northern rim of the Yosemite and gives access to the Tuolumne River country, from which San Francisco is to draw its future water-supply. The road was built in 1881 by Eastern capitalists to reach a mine, at a cost of $61,000, but has been abandoned for years.

Transmission Losses in Unlined Irrigation Channels

By Samuel Fortier*

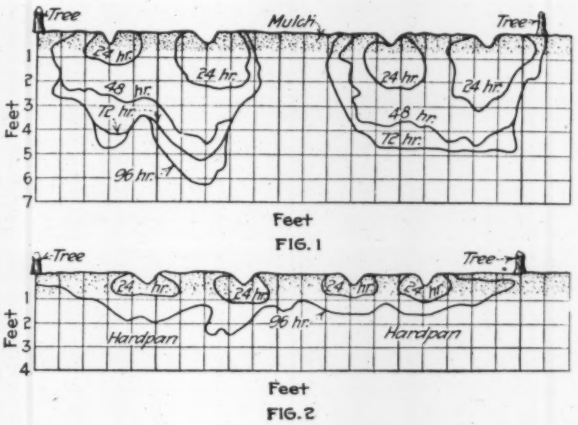
SYNOPSIS—Many seepage measurements are briefly summarized. The various factors influencing seepage are discussed, with special relation to capillarity and to depth of water in the channel.

E. S. Bellasis has pointed out in his recent book on irrigation works in India the three most needed improvements in the irrigation canals of that country. Briefly stated these are: (1) Lessening transmission losses in channels of all kinds, (2) increased economy of water in its use in the fields and (3) distribution by automatic measuring devices.

According to the 1910 census there were in the United States in that year 81,837 main and lateral ditches, aggregating 125,591 mi. in length and having a maximum capacity of 618,097 sec.-ft. In a recent publication of the Department of Agriculture (Bulletin 126) on "Concrete Lining as Applied to Irrigation Canals," the writer has estimated that over 95% of these channels, representing a total length of about 120,000 mi., was unlined at the time the census was taken and that the losses in transmission from the source to the farms averaged 40% of the total flow. While a portion of the water which escapes along the route may be recovered and utilized by means of lower canals or pumping plants, it is believed that the gain would not compensate for the losses which occur in the small ditches which form the distributary system of each farm. This estimate is believed to be conservative when both public and private irrigation enterprises are considered. The average loss in main canals, laterals and farmers' ditches on six of the larger Government projects was, according to Hopson, 44%. (See paper by E. G. Hopson, Proc. Am. Soc. C. E., Vol. 38, No. 8.) The transmission losses, as given by Kennedy, on the Upper Bari Doab Canal in India averaged, for all channels, 47% of the total flow.

Transmission losses include absorption, percolation, evaporation, leakage through defective structures and illegal withdrawals along the route. Since the amount evaporated from the surface of a canal seldom exceeds 1% of the total transmission loss and since leakage and illegal withdrawals can be controlled by good structures and efficient management, they need not be considered.

The terms "absorption" and "percolation" are here used, not wholly on account of their appropriateness, but rather because they lead back to the great natural forces, capillarity and gravity, through the action of which water is withdrawn from earthen channels. The effects of capillarity can best be observed in the smaller watercourses of irrigated farms. The irrigator makes daily use of this force to moisten soil and to place the required amount of water within reach of the roots of plants. He turns water into furrows for the express purpose of having it withdrawn by capillarity. Unlike the main canal, the furrow attains its highest efficiency when all the water is absorbed along its length. The distribution of water from furrows in the citrus orchards of southern California was investigated in 1905 by Doctor Loughridge, of the University of California, and the writer, and from the results obtained Figs. 1 and 2 are introduced. Fig. 1 shows in vertical section an outline of the four furrows between two rows of orange trees, the layer of dry soil mulch and the moistened areas at stated periods of time after water had been turned into the furrows. Fig. 2 shows the same features obtained in another orchard where hardpan interfered with the downward movement of the water, but increased its lateral distribution. These somewhat typical cases show the effect of capillarity as well as gravity. By means of gravity, water flows in the furrow, but the gradual absorption of this water is large-



Figs. 1 and 2. Effect of Capillarity and Gravity upon Water in Irrigation Furrows

ly due to capillarity. The combined action of these two forces is shown in the downward movement of water in Fig. 1. In porous soils this downward movement is greatly increased without any corresponding increase in the lateral movement.

It was stated that there were about 120,000 mi. of unlined channels used for irrigation purposes in the Western states. With very few exceptions these are excavated in earth, and when water flows through them a part is absorbed in a manner similar to that seen in the spreading of water across a sheet of blotting paper. To ignore the action of capillarity and magnify that of gravity is likely to lead to false conclusions. To assume, for example, as a recent writer on this subject has done, "that the rate of percolation of water through canal banks varies directly as the depth of water in the canal," not only ignores the effect of capillarity, but credits gravity with much more work than it performs. From the standpoint of high-school physics the pressure head due to depth of water in the canal may be an important factor, but it has little significance when applied to seepage losses from canals.

Results of Seepage Measurements

A quarter of a century ago several of the Western experiment stations began a study of duty of water. These

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efforts were later supplemented by Congressional appropriations to the U. S. Department of Agriculture for the investigation of this and kindred subjects. In prosecuting this work it was early recognized that the service which water performs in irrigation is largely dependent on the quantity of water which can be delivered to the users. In other words, it was found necessary to ascertain the loss in transmission and deduct this from the quantities appropriated and diverted from the streams. This work was quite accurately done in so far as water measurements were concerned, but little attention was paid to the many conditions which influence seepage losses. For this reason many of the early records are incomplete. Notwithstanding this defect they possess some merit; and the writer has collected in summarized form all the available reliable records of this earlier period, together with all similar records made by the Office of Experiment Stations and other agencies during the past 15 years. These have been inserted in tabular form in the publication to which reference has been made. The channels represented vary in capacity from less than 1 to over 3000 sec.-ft. and are located in various parts of 11 states of the arid region. Where the total length of canal was measured in several sections, an average of all the sections or reaches was frequently taken in lieu of the various parts; and where two or more sets of measurements were made of the same portion of a canal, the results were likewise averaged. In this way the total number of separate sets of measurements was reduced from 528 to 323. Again, in some of the original records the total length of canal tested was divided by the total loss to obtain the loss per mile. This error has been corrected in Bulletin 126 by computing the loss on the basis of the quantity of water entering each mile.

In studying the results of the measurements secured, one cannot fail to observe the close relationship which exists between the loss per mile as expressed in percentage of flow and the size of the canal. This relationship is clearly indicated in Table I, which gives in 10 groups the results of 323 tests.

TABLE I. SUMMARY OF 323 SEEPAGE MEASUREMENTS
(In terms of percentage of total flow lost per mile of channel for various sized canals)

Capacity of Canal, Sec.-ft.	No. of Tests	Av. Loss per Mi., %	Capacity of Canal, Sec.-ft.	No. of Tests	Av. Loss per Mi., %
Less than 1	16	25.7	50 to 75	31	4.3
1 to 5	37	20.2	75 to 100	26	2.7
5 to 10	30	11.7	100 to 200	45	1.8
10 to 25	49	12.1	200 to 800	87	1.2
25 to 50	48	5.5	800 and over	14	1.0

In the 16 tests or separate sets of measurements made on ditches carrying less than 1 sec.-ft., the mean depths varied from 2 to 4 in., whereas in the 14 tests made on canals carrying from 800 to 3192 sec.-ft., the mean depth varied from 5 to 8 ft. The average loss per mile in the first group was 25.7% of the flow, while in the last group the loss was only 1%. Expressed in second-feet per mile, the average losses in the two groups are 0.19 and 16.5 respectively. These results, therefore, do not seem to be in accord with the statement quoted above that the rate of percolation of water through canal banks varies directly as the depth of water in the canal. On the contrary, if the writer interprets the results aright, they show the influence of capillarity, particularly on the smaller channels with their relatively shallow mean depths and large wetted perimeters. Since some of the contributors to ENGINEERING NEWS appear to have opinions on this subject quite different from those held by the writer, it may prove worth while to review some of the main factors influencing seepage in order to arrive at a better understanding of this perplexing problem.

VARIOUS FACTORS INFLUENCING SEEPAGE

1. CHARACTER OF MATERIALS—The names and sizes of different materials usually encountered in excavating for ditches and canals are given in Table II.

TABLE II. CLASSIFICATION OF SOIL PARTICLES

Ordinary Designation	Size of Soil Grains, Mm.	Size of Soil Grains, In.
Fine gravel	2 to 1	1/12 to 1/25
Coarse sand	1 to 0.5	1/25 to 1/50
Medium sand	0.5 to 0.25	1/50 to 1/100
Fine sand	0.25 to 0.1	1/100 to 1/250
Very fine sand	0.1 to 0.05	1/250 to 1/500
Silt	0.05 to 0.005	1/500 to 1/5000
Clay	0.05 to 0.0001	1/5000 to 1/12500

As regards typical soils of the arid region, about 16% of their volume consists of clay, 36% of silt, 19% of very fine sand and 18% of fine sand. These four classes combined may thus be said to constitute about 89% of such soils. Other conditions being closely equal, the larger the size of earth grains the greater the seepage loss. The most unfavorable condition as regards this loss occurs when the earth grains are not only large but fairly uniform in size. It frequently happens, however, that open spaces in coarse material are so filled with smaller particles as to form a compact mass through which little water passes. This is exemplified in a way by the results given in Table III.

TABLE III. EFFECT OF VARIOUS TREATMENTS ON THE VOLUME OF SOILS
(In Terms of Cubic Yards)

Volumes of Original Materials							Volumes after Treatment			
Gravel	Coarse Sand	Medium Sand	Fine Sand	Black and Brown Earth	Clay	Total	Mixed but Not Tamped	Mixed and Tamped	Mixed, Moistened, and Tamped	Poured into Water and Drained
1.00	0.25	....	0.25	....	0.50	2.00	1.63	1.38	....	1.40
0.75	....	....	0.50	0.38	....	1.63	1.31	1.09	....	1.16
1.00	....	0.50	....	0.25	....	1.75	1.44	1.22	1.14	1.25
0.63	....	....	0.37	....	0.38	1.38	1.17	0.94	0.91	....
2.00	....	0.25	....	....	0.75	3.00	2.38	2.00	1.88	....
0.75	0.25	0.13	....	0.50	....	1.63	1.25	1.11	1.03	....
0.75	....	0.25	....	0.25	....	1.25	0.97	0.84	0.77	....

2. ACTION OF CAPILLARITY AND GRAVITY—The action of capillarity has already been touched upon; that of gravity will be considered under depth of water in canals and other factors.

3. THE GRADUAL DEPOSITION OF SILT—All streams used for irrigation carry more or less silt during periods of heavy runoff, while some streams are muddy throughout the year, either from surface erosion or as the result of mining operations. In transporting silt-laden water through a canal of low or medium velocity the heavy particles are deposited on the bottom and sides. This forms a natural lining which is often quite effective in preventing seepage. Such gradual deposition of silt accounts for the fact that a new canal loses much more water than the same canal after it has been in operation for several years. A case in point is that of a canal in Imperial Valley, California, where, in 1904, the seepage losses per mile were 2% of the flow. The same portion of the canal was again tested in 1910, and the loss was found to be only 0.3% per mi.

4. DEPTH OF WATER IN THE CANAL—On this topic I quote the following from Bellasis: "The depth of water is not likely to have much influence on it [the loss per hour]." In running water through a dry earth channel the loss by absorption under a depth of 6 in. is likely to be nearly as large as under a depth of 6 ft., provided the

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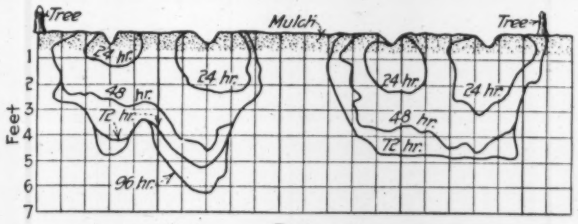

FIG. 1

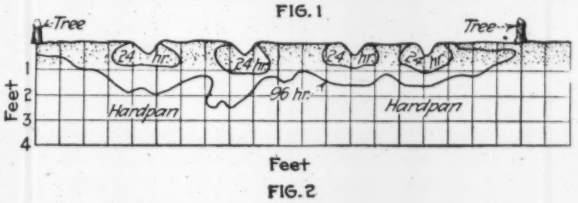

FIG. 2

Figs. 1 and 2. Effect of Capillarity and Gravity upon Water in Irrigation Furrows

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A quarter of a century ago several of the Western experiment stations began a study of duty of water. These

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efforts were later supplemented by Congressional appropriations to the U. S. Department of Agriculture for the investigation of this and kindred subjects. In prosecuting this work it was early recognized that the service which water performs in irrigation is largely dependent on the quantity of water which can be delivered to the users. In other words, it was found necessary to ascertain the loss in transmission and deduct this from the quantities appropriated and diverted from the streams. This work was quite accurately done in so far as water measurements were concerned, but little attention was paid to the many conditions which influence seepage losses. For this reason many of the early records are incomplete. Notwithstanding this defect they possess some merit; and the writer has collected in summarized form all the available reliable records of this earlier period, together with all similar records made by the Office of Experiment Stations and other agencies during the past 15 years. These have been inserted in tabular form in the publication to which reference has been made. The channels represented vary in capacity from less than 1 to over 3000 sec.-ft. and are located in various parts of 11 states of the arid region. Where the total length of canal was measured in several sections, an average of all the sections or reaches was frequently taken in lieu of the various parts; and where two or more sets of measurements were made of the same portion of a canal, the results were likewise averaged. In this way the total number of separate sets of measurements was reduced from 528 to 323. Again, in some of the original records the total length of canal tested was divided by the total loss to obtain the loss per mile. This error has been corrected in Bulletin 126 by computing the loss on the basis of the quantity of water entering each mile.

In studying the results of the measurements secured, one cannot fail to observe the close relationship which exists between the loss per mile as expressed in percentage of flow and the size of the canal. This relationship is clearly indicated in Table I, which gives in 10 groups the results of 323 tests.

TABLE I. SUMMARY OF 323 SEEPAGE MEASUREMENTS
(In terms of percentage of total flow lost per mile of channel for various sized canals)

Capacity of Canal, Sec.-ft.	No. of Tests	Av. Loss per Mi., %	Capacity of Canal, Sec.-ft.	No. of Tests	Av. Loss per Mi., %
Less than 1	16	25.7	50 to 75	31	4.3
1 to 5	37	20.2	75 to 100	26	2.7
5 to 10	30	11.7	100 to 200	45	1.8
10 to 25	49	12.1	200 to 800	87	1.2
25 to 50	48	5.5	800 and over	14	1.0

In the 16 tests or separate sets of measurements made on ditches carrying less than 1 sec.-ft., the mean depths varied from 2 to 4 in., whereas in the 14 tests made on canals carrying from 800 to 3192 sec.-ft., the mean depth varied from 5 to 8 ft. The average loss per mile in the first group was 25.7% of the flow, while in the last group the loss was only 1%. Expressed in second-feet per mile, the average losses in the two groups are 0.19 and 16.5 respectively. These results, therefore, do not seem to be in accord with the statement quoted above that the rate of percolation of water through canal banks varies directly as the depth of water in the canal. On the contrary, if the writer interprets the results aright, they show the influence of capillarity, particularly on the smaller channels with their relatively shallow mean depths and large wetted perimeters. Since some of the contributors to ENGINEERING NEWS appear to have opinions on this subject quite different from those held by the writer, it may prove worth while to review some of the main factors influencing seepage in order to arrive at a better understanding of this perplexing problem.

VARIOUS FACTORS INFLUENCING SEEPAGE

1. CHARACTER OF MATERIALS—The names and sizes of different materials usually encountered in excavating for ditches and canals are given in Table II.

TABLE II. CLASSIFICATION OF SOIL PARTICLES

Ordinary Designation	Size of Soil Grains, Mm.	Size of Soil Grains, In.
Fine gravel	2 to 1	1/12 to 1/25
Coarse sand	1 to 0.5	1/25 to 1/50
Medium sand	0.5 to 0.25	1/50 to 1/100
Fine sand	0.25 to 0.1	1/100 to 1/250
Very fine sand	0.1 to 0.05	1/250 to 1/500
Silt	0.05 to 0.005	1/500 to 1/5000
Clay	0.05 to 0.0001	1/5000 to 1/12500

As regards typical soils of the arid region, about 16% of their volume consists of clay, 36% of silt, 19% of very fine sand and 18% of fine sand. These four classes combined may thus be said to constitute about 89% of such soils. Other conditions being closely equal, the larger the size of earth grains the greater the seepage loss. The most unfavorable condition as regards this loss occurs when the earth grains are not only large but fairly uniform in size. It frequently happens, however, that open spaces in coarse material are so filled with smaller particles as to form a compact mass through which little water passes. This is exemplified in a way by the results given in Table III.

TABLE III. EFFECT OF VARIOUS TREATMENTS ON THE VOLUME OF SOILS
(In Terms of Cubic Yards)

Volumes of Original Materials							Volumes after Treatment			
Gravel	Coarse Sand	Medium Sand	Fine Sand	Black and Brown Earth	Clay	Total	Mixed but Not Tamped	Mixed and Tamped	Mixed, Moistened, and Tamped	Poured into Water and Drained
1.00	0.25	....	0.25	....	0.50	2.00	1.63	1.38	....	1.40
0.75	....	....	0.50	0.38	....	1.63	1.31	1.09	....	1.16
1.00	....	0.50	....	0.25	....	1.75	1.44	1.22	1.14	1.25
0.63	....	....	0.37	....	0.38	1.38	1.17	0.94	0.91	....
2.00	....	0.25	....	....	0.75	3.00	2.38	2.00	1.88	....
0.75	0.25	0.13	....	0.50	....	1.63	1.25	1.11	1.03	....
0.75	....	0.25	....	0.25	....	1.25	0.97	0.84	0.77	....

2. ACTION OF CAPILLARITY AND GRAVITY—The action of capillarity has already been touched upon; that of gravity will be considered under depth of water in canals and other factors.

3. THE GRADUAL DEPOSITION OF SILT—All streams used for irrigation carry more or less silt during periods of heavy runoff, while some streams are muddy throughout the year, either from surface erosion or as the result of mining operations. In transporting silt-laden water through a canal of low or medium velocity the heavy particles are deposited on the bottom and sides. This forms a natural lining which is often quite effective in preventing seepage. Such gradual deposition of silt accounts for the fact that a new canal loses much more water than the same canal after it has been in operation for several years. A case in point is that of a canal in Imperial Valley, California, where, in 1904, the seepage losses per mile were 2% of the flow. The same portion of the canal was again tested in 1910, and the loss was found to be only 0.3% per mi.

4. DEPTH OF WATER IN THE CANAL—On this topic I quote the following from Bellasis: "The depth of water is not likely to have much influence on it [the loss per hour]." In running water through a dry earth channel the loss by absorption under a depth of 6 in. is likely to be nearly as large as under a depth of 6 ft., provided the

wetted area is not increased. Again, when the water which escapes from a canal in use takes the form of capillary moisture in the soil, it is doubtful if the pressure due to the head of water in the canal increases the loss to any considerable extent. The manner in which canals are built and coated with sediment likewise tends to nullify the effect of the depth of water. The bottom of any canal of fair size is fairly well compacted and puddled by the passage of teams and wheeled scrapers of various kinds during the last stages of construction.

The effect of depth of water, however, is evident wherever the canal traverses broken rock, coarse gravel or any other porous material. It is also evident when the material through which water escapes from a canal is saturated or contains gravitational moisture. The speed and ease by which pressure can be transmitted through water are well known, and when the pressure due to depth of water can be transmitted directly through this same medium, even though the columns may be extremely small and irregular, the action serves to provide a supply for capillary distribution in comparatively dry soil and in this way increases the seepage loss.

5. Relative Extent of the Wetted Area—It is well understood that other conditions being equal the greater the wetter perimeter the greater will be the seepage due to the larger area through which water may pass. This accounts in part, at least, for the fact that the seepage loss from the smaller channels is relatively greater than that from the larger channels. Comparing two extreme cases, the wet area of a channel carrying 1 sec.-ft. is approximately 2.2 sq.ft. per lin.ft. while that of a channel carrying 3000 sec.-ft. is approximately 156 sq.ft. per ft.

6. Velocity of Flow in the Canal—The effect of velocity in lessening losses due to seepage may be observed in the canals which divert water from many of the creeks of the Rocky Mountain region. These natural watercourses, as well as the canals leading from them, flow down steep grades, and considering the porous character of the beds, the seepage losses are not so great as one would expect to find them. The Venturi meter may be mentioned as an extreme case of the effect of velocity. Under high velocities no water escapes through the opening in the throat of the meter.

Both the foregoing are, however, exceptional cases, and in keeping with the purpose of this article the influences exerted by velocity should be confined, not only to typical canals, but also to practical considerations of such canals. From this viewpoint the influence of velocity is relatively small. This is chiefly due to the fact that sediment cannot be deposited when the mean velocity exceeds a rather low limit. Of the two factors, sedimentation and velocity, the former exerts the greater influence in lessening seepage losses, so that any increase in velocity which tends to prevent sedimentation is detrimental rather than beneficial.

7. Inflow of Seepage Water—During the first stages of irrigation development in this country the lands bordering streams were, for obvious reasons, the first to be watered. In the course of time lands farther removed from the source of supply and at higher elevations were provided with water. Thus it has come about that two or more canals are frequently located on the same bench at different elevations and at varying distances apart. The water derived from the surface runoff and seepage from irrigated fields often finds its way to the next lower canal and this in turn may similarly affect still lower canals. Even under normal conditions there is apt to be no fixed regimen as regards seepage, but in the cases just mentioned very wide variations are the rule.

8. Temperature of the Soil and Water—Water flows most readily in an unobstructed channel when warm. The influence of temperature is, however, more marked when the water is forced to pass through the particles of fine soil. In experiments conducted in the Punjab, India, it was found that the rate of absorption in the three hottest months was more than double the rate in the three coldest months.

A similar effect was observed in the flow of water from

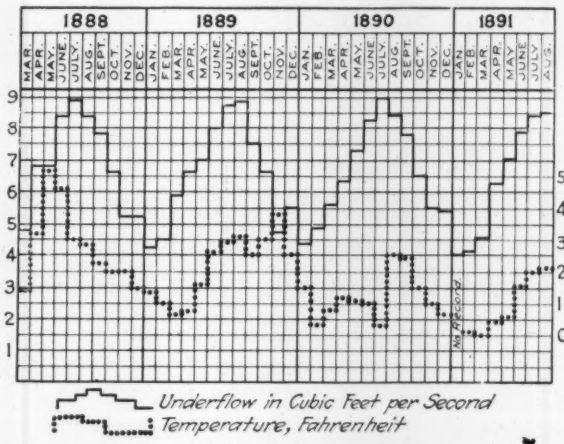

Fig. 3. Relation between Air Temperature and Cherry Creek Underflow

the horizontal galleries placed in the bed of Cherry Creek, Colorado. In 1886 the Denver Water Co. undertook to tap the underflow of Cherry Creek 15 ft. below the surface and convey the water for domestic purposes eight miles to Denver. After the plant was completed and in operation it was found that the flow as measured over a weir varied greatly with the seasons. The writer, who was engineer in charge of the construction, has frequently visited the site when the discharge from the galleries was above the average and found the bed of the creek dry 6 in. below the surface. In other words, the flow of the creek seemed to have little effect upon the quantity of water which entered the galleries 15 ft. below. The conclusion was finally reached that temperature was the controlling cause of variation in the underflow. No records of the temperature of the fine sand in the bed of Cherry Creek were available, but the temperatures of the air in the shade at Denver were taken instead. Fig. 3 shows the temperature and discharge records from March, 1888, to August, 1891, inclusive.

9. Location of the Water Table—The passage of water through saturated soils is quite different from that through soils containing only capillary and hygroscopic moisture. The same laws cannot be applied to both in the same way, since the two sets of conditions differ. For this reason the location and extent of saturated material, if any exists along the route of a canal, demand careful consideration.

10. Steepness of Slope—Closely related to the foregoing is that of the steepness of the slope at right angles to the general direction of the canal. Considering only

the force of gravity, such a transverse slope is an important factor in the movement of water through earth.

Then there is the loss of water due to evaporation from wet banks and to transpiration from trees or rank vegetation which line the ditch bank. The presence of hardpan in the soil and of moss or other aquatic vegetation in the canal is another factor which might be considered if space permitted.

[*A brief discussion of "How to Express Seepage Losses from Irrigation Canals," by the same author, will appear in a later issue.*—EDITOR.]

A Municipal Fertilizer Plant at Los Angeles, Calif.

BY BURT A. HEINLY*

In southern California, trees and shrubs under proper conditions will accomplish a growth in two years that requires six years under the less favorable climatic conditions of the Eastern states. This is due to the fact that plant growth here is more or less continuous throughout the entire year. However, for proper development, such plant life must have its wants largely met by artificial means, so that today southern California is without doubt the largest consumer of artificial fertilizer of any like area in the world. Exclusive of orange groves under association management, the Los Angeles Park Department year in and year out is the largest single user of the commodity in this district. Its present requirements are from 7000 to 8000 tons per annum.

Five years ago, even with inadequate fertilization, the expenditures to this end represented 20% of the maintenance fund for improved park area and were coming to make prohibitive the use of fertilizers in the required quantities. Frank Shearer, Park Superintendent, was instructed by the Board of Park Commissioners to devise some means by which a larger work of this kind could be carried on at a smaller expense. Mr. Shearer, who had already carried on experiments in this line under the direction of Prof. Bailey Balfour, who holds the Chair of Botany and who is regius keeper of the Royal Botanical Gardens at Edinburgh, began his work with a small plant located in one of the parks. Today, with three plants under operation, the Park Department manufactures from 8000 to 10,000 cu.yd. of fertilizer at a factory cost of $1.38 per cu.yd., and when its supply is in excess of its own demands finds a ready market for its surplus at $2 per yard at its factory.

The experimental plant was a small one of only a few cubic yards per day, the raw products comprising stable manure from the park stables, with such street sweepings as were needed, worked in combination with slaked lime and wood ashes. Here the method as now employed was worked out. The process, which is an extremely simple one, requires no particular experience and occupies about 90 days for the stable manure to pass through the fermentation and pulverization period before being ready for use.

In 1910, the building of a race track at Exposition Park and the stabling of 300 horses at that point made it possible to enter upon the manufacture of the fertilizer on a commercial scale. The plant there erected is adjacent to the stables and consists of a 30x150-ft. one-story frame building. Along the entire length of the east side of the building, a concrete-lined pit, 12 ft. wide, 5 ft. deep, and with a gradient of 1 ft. to 140, was built. A groove along the middle of the pit drains into a 2500-gal. well at the north end, equipped with a 1½-in. centrifugal pump, driven by a 5-hp. gas engine. The other half of the building comprises a concrete deck, level with the lip of the tank, for the reception of the material after fermentation. Two sides of the building are a series of 10-ft. sliding doors for the reception of the manure from the east and its delivery as a finished product on the west. Collections of the manure are made in two-wheeled carts once each day from the sanitary containers supplied by the Park Department to each stable.

The filling of the pit is begun at the end farthest from the well, the collection cart dumping directly into the pit. The manure is tramped fairly solid after each load and piled in 10-ft. sections to a height of about 5 ft. above the level of the mouth of the pit, which gives about 1200 cu.ft. to the section. One 10-ft. section holds about two days' output of the stables, and every other day sees one section filled with new material and another section emptied of the ferment or "mash," so that the vat is progressively filled and emptied each day.

Fermentation of the mash begins of its own accord, usually soon after the manure enters the pit, communicating itself from section to section, the high temperature of a section that is already started making the bacterial growth very active.

A hot-bed thermometer is placed in each section, and the aim is made to keep the temperature as closely as possible around 100° F. When the temperature rises above this point, the mass is sprinkled with water sufficient to produce a temperature of about 80° F., but not in sufficient quantity to wash out the fermentation elements. The water passes through the pile and drains into the well, being used again and again on the other sections until it has become an extremely strong agent. This is then drawn off and after proper dilution is used as a liquid fertilizer, in the greenhouses and forcing gardens.

If the fermentation is slow in starting, which will be the case if there is a large amount of straw, the action is accelerated by spraying with a weak solution of chloride of lime, wood ash and soot. The period of fermentation is from 20 to 30 days, in which interval wetting down may be necessary from three to four times. When, without spraying, the temperature ranges around 90°, the spraying is discontinued and the pile allowed to stand until the temperature falls to between 60° and 70° F. The mass now has about the consistency of ensilage, and because of the fermentation heat all germinating power of weed seeds as well as spores of fungoid growths has been destroyed.

The contents of the section are then forked on to the deck in layers one foot thick, on which are spread 5% (by volume) of wood ashes, 2% of slaked lime, and over this a layer of loam soil, ranging from 50 to 150% in volume, dependent upon whether the manure was pure or mixed with much straw. The loam is added to keep up the volume of the mass, arrest and absorb the gaseous elements and excess moisture, and prevent a too rapid disintegration of the material. The pile is built up in this way to a height of about 8 ft. A pulverizing process now begins, and at the end of sixty days the product is well disintegrated and dried so that 80% will pass through a ½-in. mesh.

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That remaining on the screen is returned to the pit. The fertilizer is now ready for use. As the manure is taken from the stables, it runs about 800 lb. per cu.yd. Through shrinkage and the addition of lime, wood ash and soil, the weight of the prepared material amounts to about 1800 lb. per cu.yd. Storage facility at the present time is not provided for more than a six months' supply. In storage, where the material is under cover, there is very little loss in bulk, and as the chemical action is arrested the product can be kept indefinitely in an unimpaired condition.

The fertilizer, when the process is properly carried on in its dry state, is almost odorless. Upon application, when it first comes in contact with vegetation, a reversal of the process begins, with a freeing of the chemical elements. Some odor then arises, but this passes away within three or four hours.

The year after the Exposition Park plant was established, the city began the collection of its garbage. At the loading station, where 200 head of stock are stabled, the Park Department duplicated its Exposition Park plant. Here the straight amount of raw manure amounts to 5 cu.yd. per day, with 5 to 8 yd. of wet straw once a week. The manure from the stables at Exposition Park is always mixed with much litter, as the racing stock is well bedded.

In Elysian Park a third plant has just been completed to do the same work, but by the dry process. A thatched shed, 40x100 ft. in plan and 12 ft. high, has been built to cover a small unlined pit of the same area. The manure is laid down in 1-ft. layers, tramped, and soil and wood ash added in the same quantity as with the wet method. The pile is built up to a height of 8 ft. This process, while requiring less handling, consumes six months, as the chemical action is slower. The lime is not added until the mixture is screened, as to mix it at the time the pile is laid would be to impair its strength.

All the wood ash is prepared by the Park Department by the burning of all tree prunings and refuse vegetation of the parks. On the side of a hill in Elysian Park a pit has been excavated, the wagons dumping from above and the firing being almost constantly in progress. A like kiln is also run at Griffith Park, an area of 3015 acres in its natural state, where clearing of brush is usually under way. Exclusive of the profit in a cheap way of ridding the parks of waste, the cost of ash figures at $2 per ton.

The slaked lime, as at first used, cost $15 per ton, f.o.b. Los Angeles. There is, however, a waste product of cement mills, the impalpable dust rising from the limestone crushers, which Mr. Shearer, on an inspection of the municipal cement plant at Monolith, discovered to be a perfect substitute. The mill was glad to get rid of this for the cleaning of the crusher building, and for several years Mr. Shearer procured this ingredient at a cost of labor and freight which amounted to $2 per ton, f.o.b. Los Angeles. As the municipal mill has not been operated for the past eighteen months, the supply is purchased from a private mill at $3 per ton, delivered in Los Angeles.

The cost of the fertilizer, the department figures at $1.38 per cu.yd., f.o.b. factory, the expense divided as follows: Collection of manure, 25c.; lime and wood ash and hauling of loam, 33c.; fermenting, forking and mixing, 25c.; screening, 50c.; interest and depreciation, 5c.; total, $1.38.

The application of the product on shrubs and lawns under construction is made to a depth of 3 in., which is turned in. On the lawns it is used unscreened with a saving of 50c. per cu.yd. On new lawns this would amount to 270 cu.yd. per acre. As a top dressing it is spread ¼ in. thick, or 1 cu.yd. to 144 sq.yd. of lawn. One application made in early spring, with a light dressing of blood-and-bone fertilizer in the middle of summer, suffices for the year.

The municipal fertilizer is believed by Mr. Shearer to be superior to anything else available. The combination produces a fertilizer in which there are present all the principal elements in approximate proportion to that required by plant life. A most important element is that it contains the humus required to retain necessary moisture and to give off the sustaining virtues of the compound as they are needed, and that without the weed seeds that make a natural fertilizer unprofitable, from the amount of weeding that follows its use.

The Park Department estimates that, with less profitable results, fertilization on the present scale with commercial fertilizers would cost not less than $25,000. As the expenditure on the municipal-fertilizer plants reaches approximately $12,000 per annum, this would mean a saving of around 50 per cent.

As will be seen from the foregoing, it is difficult to state the comparative value of this and commercial fertilizers in terms of dollars and cents. The department estimates, however, that with less profitable returns, fertilization on its present scope could not be undertaken with commercial fertilizers for less than $25,000. As the expenditure on the municipal fertilizer plants reaches approximately $12,000 per annum, this would mean a saving of around 50 per cent.

Quick-Closing Door for Pressure Cylinders

A novel quick-opening and closing door for steel cylinders under pressure was recently manufactured by the Vulcan Iron Works, Wilkes-Barre, Penn. The door was designed especially for use in connection with steam preparators at sawmills—steel cylinders in which lumber is prepared for drying. Jerome A. Sheip, Inc., Mobile, Ala., for whom the door was made, wanted a door that could be opened or closed in 5 min. or less. The new door can be either opened or closed in 30 sec. Most doors used for this class of service are closed and made tight by means of numerous bolts and nuts, the manipulation of which requires considerable time. The Vulcan door maintains a tight joint under pressure without the use of bolts. The cylinder pressure is 25 lb. per sq.in.

The design is not at all involved, as shown by the views and drawing. Riveted to the operating end of the cylinder is a cast-steel ring with flange projecting inward. All around the flange on the inside of the ring is a piece of packing. The door is operated on a double hinge and a pivot in the center.

Method of Opening and Closing Door

To close the door, the operator with bar in hand, as shown in Fig. 1 (right), moves the door into a recess on the right of cylinder, until the left side of door clears the flange and enters the cylinder. After the door has en-

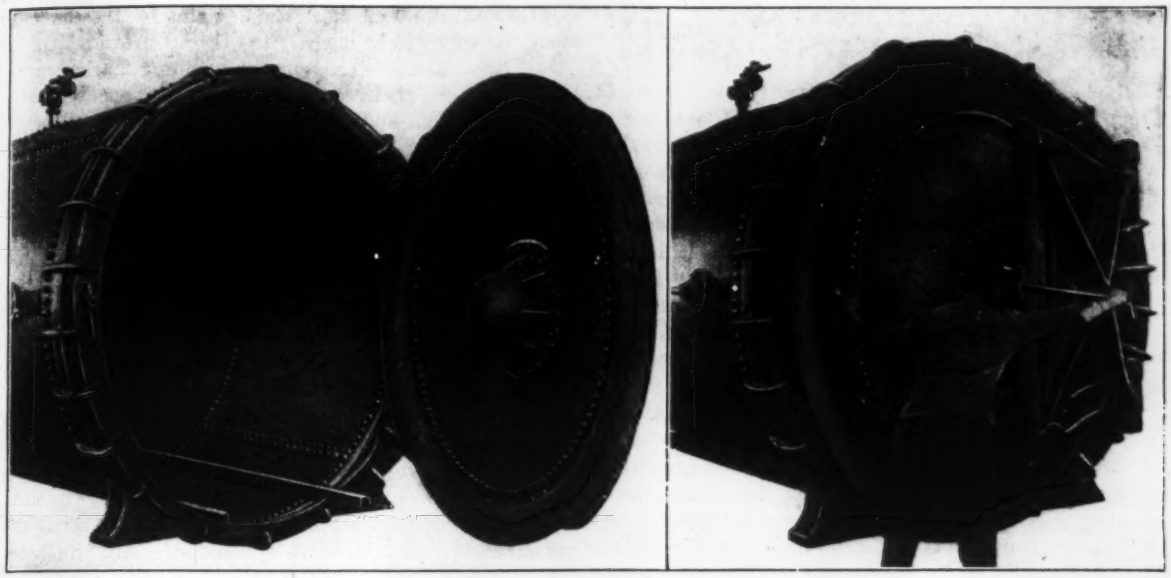


FIG. 1. (LEFT) THE NEW DOOR IN OPEN POSITION; (RIGHT) CLOSING THE DOOR

tered the cylinder the operator reverses this movement, making the door central with the opening in the hold-back flange.

The bar is then inserted in the eyes on the outer circumference and the door is revolved on its center pivot, making one-quarter of a revolution, or until the wide portion of the door completely covers the enlarged openings in the hold-back flange. In making this quarter turn the door is automatically centered and placed in position by the steel guides shown at the top and bottom of the door. The steam is then applied to the cylinder and the door is forced against the packing and sealed.

To open the door the steam is exhausted and all the movements mentioned in the foregoing are reversed. As the hinges are fitted with ball bearings, one man can operate this door with ease.

USES OF THE NEW DOOR

The door was designed especially for use on steam preparators. It is claimed that the time required for drying lumber thus prepared is only 25% of that ordinarily required, and that the weight of this lumber is 200 to 500 lb. less per 1000 ft. b.m., with consequent saving in freight. One cylinder or tank can handle 60 to 70 M ft. b.m. in 8 hr. Each tankful is steamed 15 min. to eliminate the sap. This means frequent opening of the door; hence the desirability of speed.

The door has application in other industries. The cylinder used for drying and hardening sand-lime brick needs a door of just such design, as do also vulcanizers and creosoting cylinders. The door can be made just as applicable to cylinders operating under vacuum as those under pressure, by the simple addition of an interior flange. With this minor change, the higher the vacuum is, the tighter the joint is.

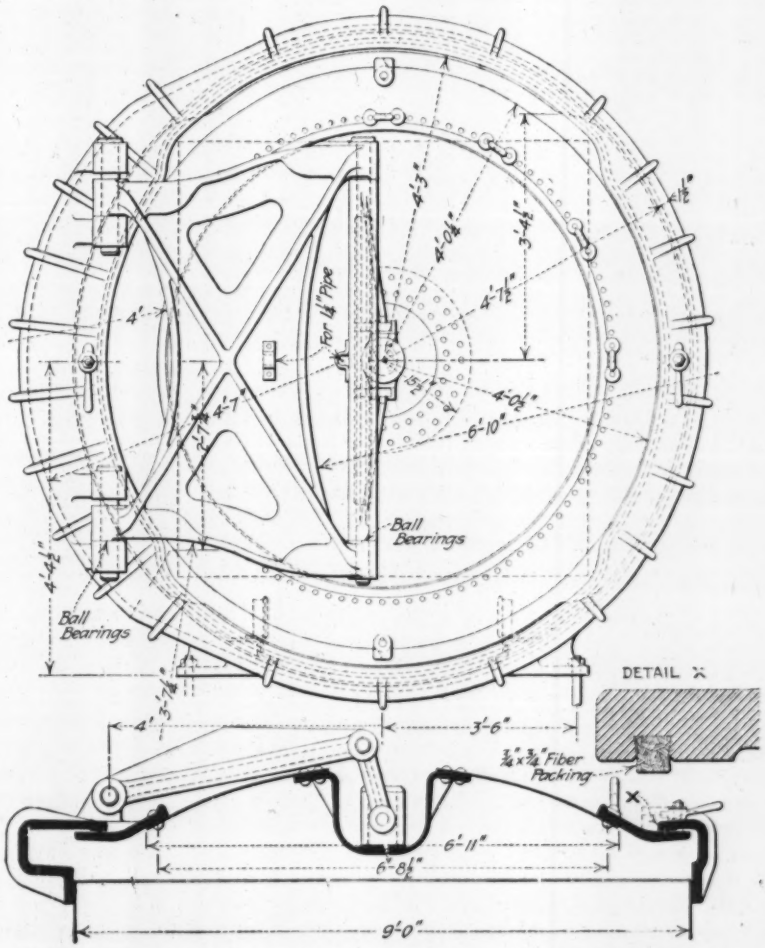


FIG. 2. DESIGN OF QUICK-OPERATING DOOR FOR PRESSURE CYLINDERS

Port Improvements along the Mississippi and Ohio Rivers

The recent renewal of the proposition for development of inland navigation and the improvement of river ports has led ENGINEERING NEWS to make an inquiry as to the development of shipping facilities at various towns and cities along the Mississippi and Ohio rivers. The results are somewhat meager and indefinite and do not indicate a probability of any marked increase in river traffic in the near future. In cities where improvements are being made there seems to be an idea that these will assist in developing river transportation, but little or no information is available as to definite prospects of new boat or barge lines.

Some cities are frankly skeptical as to developments in river traffic. Other cities, while expressing an optimistic view as to an increasing traffic, admit that they are doing nothing to provide additional facilities, either for accommodating vessels or for handling freight. Several river towns have no municipal facilities, and the private ones consist of the wharfboats of steamboat companies and the docks or wharves of gravel and coal companies. In many cases (probably most cases) the municipal river-front improvements include park and recreation, as well as traffic, facilities.

It is important to bear in mind that the river-transportation systems are organized entirely on the basis of local traffic. Few boats make long "through" trips, and (as a rule) freight shipped over long water routes would have to be handled by a series of boats of various lines. This increases the time and cost of transportation and the liability of loss or damage in handling. With railway transportation the freight loaded on the car may pass over a dozen railway lines, but will never need to be handled until it reaches its destination. Furthermore, the shipper by rail can get a bill of lading covering the entire route to destination. But in river transportation it is rare that a bill of lading can be had to cover the several independent but connecting links of a water route.

A summary of the information obtained is given in what follows, omitting reports from places where nothing is being done or contemplated. It may be noted that our inquiry related specifically to two points—accommodations for vessels by levees, wharves, etc., and facilities for handling and storage of freight. It did not include channel improvements, which are in the hands of the Federal Government.

UPPER MISSISSIPPI RIVER

Minneapolis—This is the head of navigation, the new dam (with lock) below the city giving a navigable depth of 7 ft. A municipal wharf will be completed this spring having a concrete wall about 1050 ft. long (ENGINEERING NEWS, July 30, 1914) and 150 ft. of paved slope. This wall is built in 30-ft. sections, with expansion joints having a filling of tarred felt. The bottom is in the St. Peter sandstone and 4 ft. below the proposed bottom of the channel. Heavy excavation was required at some points in cutting through a limestone bed above the sandstone. The work was planned by Frederick W. Cappelen, City Engineer.

The city appropriated $75,000 for this purpose, and a bill has been introduced in the state legislature to authorize bonds for a warehouse, freight-handling machinery and further improvements. The dredging for the channel along the wall will be done by the U. S. Government.

St. Paul, Minn.—The city is planning harbor and levee improvements in connection with the river diversion which is to be made to provide room for the new railway terminals (ENGINEERING NEWS, Mar. 11, 1915). This will more than double the present levee facilities. The Commissioner of Public Utilities favors the establishment of municipal docks or wharves equipped with freight-handling machinery. Oscar Claussen is Chief Engineer of the Department of Public Works.

La Crosse, Wis.—A city ordinance has been introduced to create a port commission having full charge of terminals. George P. Bradish is City Engineer.

Davenport, Iowa—The city has a levee improvement commission which is developing the waterfront for shipping and commercial purposes. It is constructing a masonry sea wall on the dock line established by the U. S. War Department and filling the space behind it. On this land it is laying out a public park and building a series of railway and water terminals equipped with modern freight-handling apparatus. Five of the 100-ft. terminal lots have been leased to private interests, though they are not quite completed.

About 4000 ft. of river wall has been built and 18 acres of land reclaimed in the heart of the business district, and this is only 25% of the work. In 1915 there will be a 1400-ft. section of wall completed and about five acres of land reclaimed. The work is self-supporting both as to interest charges and amortization, no taxation (direct or indirect) being called for. A. M. Compton is Supervising Engineer for the commission.

Rock Island, Ill.—It is proposed to establish a harbor line and to build a levee with docks, etc., and to commence work during the present year.

Muscatine, Iowa—During 1914 only a little filling was done on the river front. The City Council and the levee commission are endeavoring to finance the construction of a levee and retaining walls at an estimated cost of $15,000. C. H. Young is City Engineer.

Keokuk, Iowa—In connection with the new lock and dam, the U. S. Government has established a harbor line about 100 ft. out from the present shore for about 2500 ft. Filling has been in progress during the winter, and it is expected that work will be commenced soon on the river wall. Beginning at the Keokuk & Hamilton bridge (3000 ft. below the dam) there will be a river wall or harbor wall for 600 ft., with a park on the filled land behind it. Beyond this will be 600 ft. of sloping levee, paved with stone, for the accommodation of river steamers of the old type. Beyond this levee will be 600 ft. of vertical river wall, with warehouse and freight-handling machinery on the filled-in land. J. F. Winters is City Engineer.

Quincy, Ill.—In 1914 a waterfront terminal committee was organized representing the city, the Chamber of Commerce and the local freight bureau. The plan approved at a public meeting in December comprised three features—(1) acquisition by the city of a 20-ft. right-of-way along the river front for a municipal belt railway; (2) extension of the U. S. harbor line; (3) the establishment, operation and maintenance of municipal terminal facilities on the waterfront. The last-mentioned feature would provide for a river wall in such depth of water as to accommodate vessels at the lowest stage of the river; mechanical appliances for handling freight to and from

vessels and cars; a municipal railway parallel with the river wall, and public warehouses. William K. Abbott is chairman of the committee. Frank Beckwith is the engineer and has prepared plans for the proposed work.

Alton, Ill.—A harbor line is to be established by the U. S. Government. An exchange of property between the city and the Illinois Terminal R.R. is proposed, by which the former would secure possession of a strip of waterfront property 2000 ft. long and 100 ft. wide, which would be a valuable site for a municipal levee and wharf. J. E. Schwaab is City Engineer.

Lower Mississippi River

St. Louis, Mo.—A comprehensive system of wharves and docks, with railway terminals and warehouses, is proposed, but no definite plans have been adopted. The construction of docks in the near future is contemplated, and it is expected to acquire some 11 miles of existing railway track on the river front, the franchise for this line expiring in 1915. Along this will be built freight houses and warehouses for water-borne traffic. The work is in charge of James A. Hooke, Director of Public Utilities.

East St. Louis, Ill.—The extensive river-front levee built as part of the drainage district improvements was described in Engineering News, Feb. 5, 1914. The city has now made arrangements by which the Wiggins Ferry Co. will maintain a wharfboat (just south of the Eads bridge) for the free use of shippers. The Kansas City & Missouri River Transportation Co. has a water terminal near this location, and improvements were made in 1914. An electric traveling crane serves the warehouse and tracks, and also extends over the water, so that it can handle freight directly between cars and barges. An endless-chain conveyor was also installed. This is 70 ft. long, with a capacity of about 2 tons, and can be adjusted to any stage of the river.

A new waterfront terminal opposite Carondelet was opened for traffic in April, 1915, by the Alton & Southern Ry., which is a 15-mi. terminal and belt line serving the industrial district around the city and connecting with the several trunk lines. The terminal will accommodate several large barges and is equipped with mechanical devices for handling freight. A traveling crane handles heavy articles between the barges and cars, while conveyors handle the package freight. Special facilities are provided for the economical shipping of coal. This is received in drop-bottom cars and is dumped into a hopper, from which it is delivered by chutes to the barges.

Cape Girardeau, Mo.—The St. Louis & San Francisco Ry. has its main tracks laid along the river front, but in renewing the franchise (for 30 years) the city required extensive improvements to be made. It gave the railway merely a right to operate over this right-of-way, and required it to permit other roads to use the tracks. The city retains ownership of the waterfront, with control of the levees, wharfage and warehouse privileges. A levee about two blocks in length is paved with granite from the toe wall at the river's edge to the top of the incline at Water St., which has creosoted-block paving. Pockets or depressions are provided in this slope, so that freight can be handled at any stage of the river.

South of this levee a considerable stretch of land is being reclaimed by building a retaining wall across a deep bend in the river and filling the space behind it. For a distance of about three blocks this will be laid out as a park, with the tracks running through it and a new passenger station in the center. Nothing has been done as yet toward installing devices for the mechanical handling of freight, but such equipment is expected to be put in later, as the river traffic is considerable.

Memphis, Tenn.—No waterfront improvements are contemplated at present, but it is intended to investigate the matter of suitable terminal facilities. The city has paved levee more than sufficient to accommodate the boats now running, and new work will depend largely upon development in river traffic.

Helena, Ark.—An extensive levee enlargement has been made, at a cost of about $225,000, by an improvement district organized under the state law. This work protects the city from floods, although the district covers much more territory than the city.

New Orleans, La.—The conditions here are different from those at up-river points, in that New Orleans is both a seaport and a river port. There is a wharf built specially for river boats and barges and equipped with belt conveyors for handling package freight to and from the vessels. This equipment is to be increased, and experiments have been made with portable conveyors. It is expected that the additional plant will be decided on during 1915. Other means for improving the facilities for steamboat and barge traffic are also under consideration.

The port has nearly six miles of public wharves, mostly covered with steel sheds, and all this wharfage is available for barges. The barges and river steamers can also receive or discharge freight at ocean vessels moored at any of the piers or in midstream. About 80% of the wharfage is owned by the state. It is proposed to erect warehouses directly in the rear of the wharf sheds for the storage of freight at a low rate. Several kinds of freight-handling equipment are being studied, and the harbor already has considerable apparatus of this kind. One of the latest improvements is the construction of a cotton terminal and warehouses with capacity for handling 2,000,000 bales annually and for storing 470,000 bales. The warehouses will include the cell or compartment system as introduced at the Trafford Park terminal of the Manchester Ship Canal (England), described in Engineering News, Dec. 12, 1912.

Another improvement, noted in the issue of Mar. 18, is the construction of a ship canal from the river to Lake Pontchartrain. This will have slips or docks at various industries in the manufacturing district behind the city. New Orleans has also a municipal belt railway, with 50 mi. of track, which extends along the river front and connects with the trunk lines. It is operated by the city (which owns locomotives only), and provides convenient service for handling cars between the railways, docks, factories, warehouses, etc., at a flat-rate charge of $2 per car. The revenue has exceeded the expenses of operation and maintenance and the depreciation of locomotives. It is to be extended to encircle the city and develop new industrial districts.

The management of the port is in the hands of the Board of Commissioners of the Port of New Orleans. Samuel Young is Chief Engineer of the Board; Ford, Bacon & Davis, of New York, are the consulting engineers for the new cotton terminal and the Lake Pontchartrain Canal.

On the Ohio River the prospects for port work in the immediate future are very poor. So much has been said about the importance of traffic on this waterway that it is rather surprising to find that the work of improving facilities for boats and for handling freight is so limited as to be negligible. Of twelve cities, including Pittsburgh and Cincinnati, all report that no work of this kind was done in 1914 and eleven report that no such work is contemplated for 1915; although two cities state that they are investigating the matter.

The usual accommodation at Ohio River ports consists of a paved sloping river bank or levee belonging to the city, with wharfboats moored near the bank. These boats and the river-front warehouses (if any) are owned generally by private interests. Boats tie up either at the levee direct or at the wharfboats. The freight is handled almost exclusively by teams, which drive down the paved levee to the wharfboats or the steamers' gangplanks.

As to the river traffic at these ports, Evansville, Ind., alone reports that this is of such extent as to warrant something better than "the antiquated wharf-boat system." Others make no reference to it or are frankly pessimistic. One says that while it has advocated river transportation, there is little such transportation to improve. For Wheeling, W. Va., it is stated that the river traffic does not amount to much now, and that it is doubtful whether anything will need to be done toward improving local facilities until the completion of the Government improvements renders the Ohio River navigable throughout the year. This condition is hoped for within the next decade.

Mr. Weil, president of the Evansville Business Association, takes the same view as to the river work in progress. But he considers that now is the time to improve the shipping and terminal facilities, and that self-propelled barges must supersede the ordinary steamers if river traffic is to be developed successfully. The prospective improvements are as follows:

Evansville, Ind.—A port commission was appointed by the mayor (Mr. Bosse) early this year to investigate the needs and to determine whether it would be advisable to introduce some better means of handling freight than by hauling it with teams up and down the steep levee. J. H. Berryhill is secretary of the commission. A plan proposed by Mr. Weil includes land reclamation by filling to an established harbor line (a width of from 300 to 500 ft.) for a length of several city blocks. Part of this would have a river-front wall and the rest would be a levee. Railway tracks should be provided, owned and operated by the port commission.

New Albany, Ind.—The matter of better wharf facilities is being considered by the Board of Public Works, the City Engineer and a committee of the Chamber of Commerce. The City Engineer is preparing plans and estimates for a new wharf.

Louisville, Ky.—It is expected that this year about 5000 sq.yd. of the public wharf will be paved with concrete blocks. The wharf has now a 40-ft. paved roadway at the low-water line, and it is intended to widen this until the entire wharf is paved.

Cairo, Ill.—A paved-slope wharf, which has been in use for 35 or 40 years, extends ¼ mi. along the business part of the town, and has a large two-story wharf boat moored in front of it. This wharf is owned by a private corporation which controls the wharfage of the entire town. Towing companies maintain extensive yards, renting their wharfage rights and privileges from the above company. There is a private coaling plant for supplying coal to boats, and three lumber inclines (two of the I. C. R.R. and one of the C., C., C. & St. L. Ry.) provide for handling lumber direct from barges to cars. Two elevators (of 1,000,000 and 600,000 bu. capacity) owned by private interests are located on the Ohio river front and can be equipped for handling river traffic. All the sheds and warehouses which were formerly used for river traffic in the good boating days have been destroyed by fire or removed through lack of business.

New Smith Solar Attachment

By Arthur D. Kidder*

The working parts of the Smith solar attachment consist of five fundamental features:

1. An auxiliary telescope, whose line of collimation is the polar axis of the solar attachment. The telescope may be revolved in collar bearings, which are securely mounted on a vertical limb.
2. The vertical limb, mounted on a horizontal axis and having a graduated latitude arc in its vertical plane.
3. A plane mirror at the objective end of the auxiliary telescope with an axis normal to the line of collimation, and an arm leading to a graduated declination arc.
4. An hour circle on the auxiliary telescope mounted normal to the line of collimation.
5. A set of equatorial wires parallel to the axis of the reflector.

In all the forms of construction of the Smith solar attachment the auxiliary telescope is mounted in a vertical plane parallel to the transit telescope. Thus, if the instrument is in proper adjustment and oriented to the true meridian, the polar axis of the solar attachment may be made parallel to the earth's polar axis by setting off the true latitude of the station.

The sun's rays are brought into the auxiliary telescope by means of the mirror, due allowance being made for the sun's declination north or south of the equator; but to bring the sun's image into the auxiliary telescope the latter must be revolved in its collar bearings until the reading of the hour circle agrees with the sun's apparent time.

When the auxiliary telescope is thus revolved the sun's image will traverse the field of the eye-piece parallel to the equatorial wires with the limbs of the disk tangent to the wires. If the transit is turned in azimuth the sun's image will immediately depart from the equatorial wires, except at noon, when the image will follow the equatorial wires whether the transit be turned slightly in azimuth or the auxiliary telescope be revolved in hour angle. At apparent noon the declination arc is in a vertical plane, and at this time an absolute determination may be made of the correctness of the reading of this arc.

The new Smith solar attachment made by Buff & Buff (Jamaica Plain, Boston, Mass.) is mounted upon the east standard of their regular light mountain model engineer's transit. The horizontal distance between the vertical planes of the transit and auxiliary telescope is a trifle less than 4 in. The auxiliary telescope has a focal length of 4¾ in. and a magnifying power of about 10

*Supervisor of Surveys of the General Land Office, Washington, D. C.

diameters. Both telescopes are fitted with the necessary colored-glass shades for observing the sun.

The latitude arc has a radius of 3 in. and the declination arc has a radius of 3½ in. On the declination arc the graduations read the true declination, and, as the mirror needs to be turned only 5° to correspond to a change of 10° in the sun's declination, the graduations are one-half the angular amount. At zero declination the plane of the mirror is at 45° to the line of sight of the auxiliary telescope.

The essential features of the Buff improvements over older models are:

1. The solar has been mounted upon an instrument having U-shaped standards, thereby adding much to the stability of the attachment.

2. The base plate of the solar is mounted upon three foot-posts, thereby relieving the strain due to imperfect adjustment of the older models having a four-point base.

3. The position of the base-plate is adjustable by means of opposing capstan nuts on the foot-posts, each with a countersunk ball washer, thereby obtaining positive adjustment altogether free from strain on the capstan nuts.

4. The three-point base forms a right-angle triangle, with one side horizontal and one side vertical, thereby permitting adjustment in either of two directions—(a) one about a horizontal axis and (b) one about a vertical axis, either without disturbing the other.

5. The axis of the latitude arc is so arranged that its position may be tested with a striding level without removing the anxiliary telescope.

6. The latitude arc and auxiliary telescope are both hung underneath the latitude axis, thereby lowering the center of gravity of the attachment and giving much greater protection to the delicate working parts.

7. Suitable capstan nuts have been placed at one end of the auxiliary telescope to provide for its proper adjustment with respect to the axis of the latitude arc.

8. Improved interlocking devices have been placed on the latitude and declination arcs, verniers, clamps and tangent motions.

9. The mirror may be swung around instantly to permit direct sighting through the auxiliary telescope.

10. Absolute freedom of motion of the various working parts, each to perform its own function, and each one independently, quickly and permanently adjustable.

The field adjustments of this solar attachment should be considered in the following order:

1. The equatorial wires must be made parallel to the axis of the reflector.

2. The line of sight of the auxiliary telescope must lie in its true turning axis.

3. The line of sight of the auxiliary telescope must be normal to the axis of the latitude arc, describe a true vertical plane when turning on said axis, and this vertical plane must be parallel to the vertical plane of the transit telescope.

4. The latitude arc should read zero when the auxiliary telescope is horizontal.

5. The declination arc should at all times read the true declination of the sun plus the refraction in polar distance.

6. The hour circle should read the sun's apparent time.

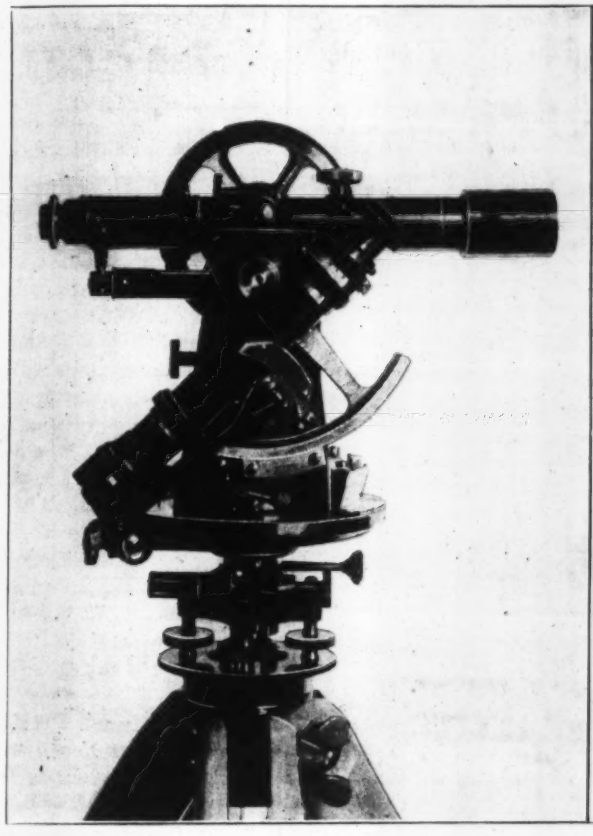


FIG. 1. NEW SMITH SOLAR ATTACHMENT OF BUFF & BUFF; IN POSITION FOR USE

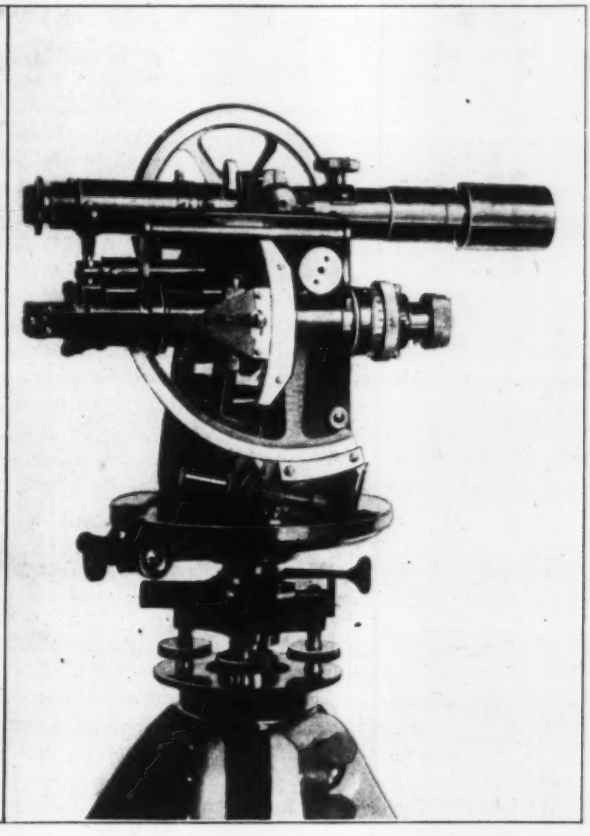


FIG. 2. NEW SMITH SOLAR WITH STRIDING LEVEL FOR TESTING LATITUDE ARC

TO USE THE SOLAR ATTACHMENT

Before using the solar attachment the latitude of the station and the sun's declination (properly corrected for refraction in polar distance) must be known and accurately set off on the respective arcs. The instrument is carefully leveled and the apparent time set off on the hour circle. The transit is then oriented to the meridian.

The plates are generally first set to zero and the sun's image brought into the field of the solar telescope before setting the lower clamp; thereupon the sun's image is brought accurately between the equatorial wires with the

lower tangent motion. This gives the solar meridian. The transit may then be used for any normal function. The solar meridian may be tested as many times as desirable by simply setting the plates back to zero and turning the auxiliary telescope in hour angle to the apparent time. This brings the sun's image again to the center of the field.

The sun's declination is constantly changing at a very slow rate, so that it is necessary to correct the reading on the declination arc with its tangent motion to agree with the declination of the sun for the apparent time of observation.

The great advantage of the Smith solar over all other forms of solar attachment is found in the fact that the latitude and declination arcs remain clamped while the transit is being used in any normal function. Upon setting up at a second station it is necessary merely to correct the latitude and declination arcs with their tangent motions to agree with any change from the previous station. For this reason it may be operated more rapidly than any other form of solar attachment. In fact, the solar meridian is so quickly determined that the observation is usually repeated at every station.

The latitude of the station should always be determined with great care. Altogether too many maps are unreliable in this respect. The direct altitude observation upon the sun for latitude is so simple and the reduction so easy that every operator of a solar transit should make it a practice to accomplish direct observations on the sun for latitude on as many successive days as may be necessary to give him a reliable determination of the true latitude of any unknown station.

Test of a Peculiarly Designed Concrete Slab

The accompanying diagram (Fig. 2) gives the result of one test of a series made by B. L. Fixen for C. A. P. Turner, Minneapolis, Minn., on a reinforced-concrete slab in which an ordinary two-way reinforcement is supplemented by a spiral of reinforcement lying on the cross-rods.

In building the test slab, four L-shaped corner footings were set up of cement blocks bonded with a rich mortar. A timber beam was then set across the openings, and two

FIG. 1. A CONCRETE SLAB WITH PECULIAR REINFORCEMENT

courses of brickwork laid all around on the beams and stonework. Upon this brickwork the slab was cast. Subsequently, piers were put in under the center of each wooden beam. The concrete was a 1:2:4 mix, of which two cylinders averaged 1755 lb. per sq.in. at the end of 153 days.

The reinforcement consists of a ⅜-in. round spiral placed on a two-way reinforcement of ⅜-in. round rods spaced 8 in. c. to c. The spiral was 6 ft. 8 in. diameter and was held in position by clamping it to two ⅞-in. channels which were so punched as to serve as spacer bars. The lower belt of rods was placed ⅜ in. clear of the forms in

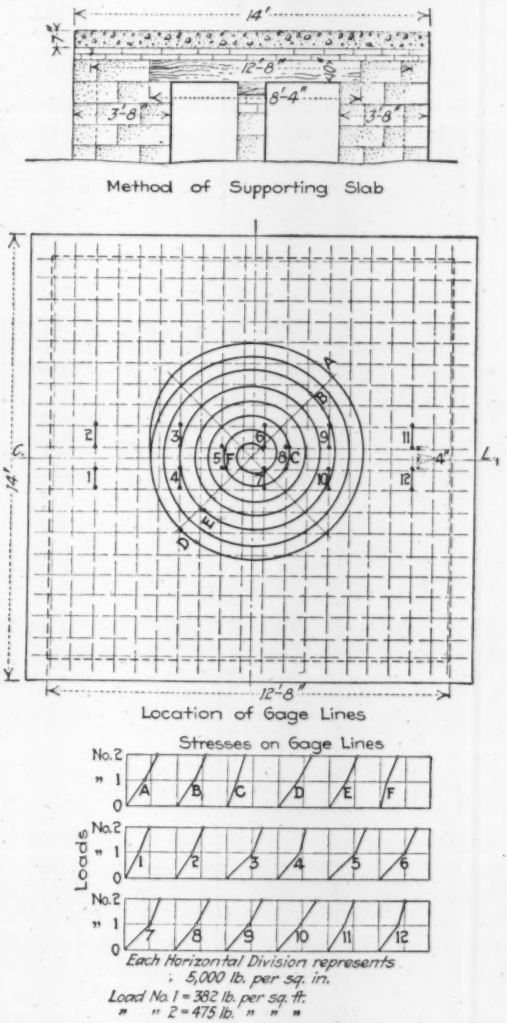


FIG. 2. LOG OF TEST ON SPECIAL SLAB

the center of the span and ⅜ in. clear of the supports, the upper belt of rods resting directly on the lower belt.

Gage points (12 in. c. to c.) were placed as shown in Fig. 2, those on the straight rods being in the lower belt. Test loads of pig iron were applied 109 days after the slab was cast. The steel deformations shown in the diagram were measured with Berry extensometers.

Elevator, Boiler and Flywheel Accident statistics are regularly collected by the Fidelity & Casualty Co., of New York City, as noted in these columns at various times. The figures for the United States and Canada for February and March, 1915, show 96 elevator accidents, only 13 of which were due to falling lifts. Only one person was killed and 14 injured by the falling elevators, while in the 83 shaft and door accidents 39 people were killed and 45 were injured. Practically all these last casualties could have been prevented by safety gates and interlocked shaft doors.

Steel Frame for a Large Electric Sign

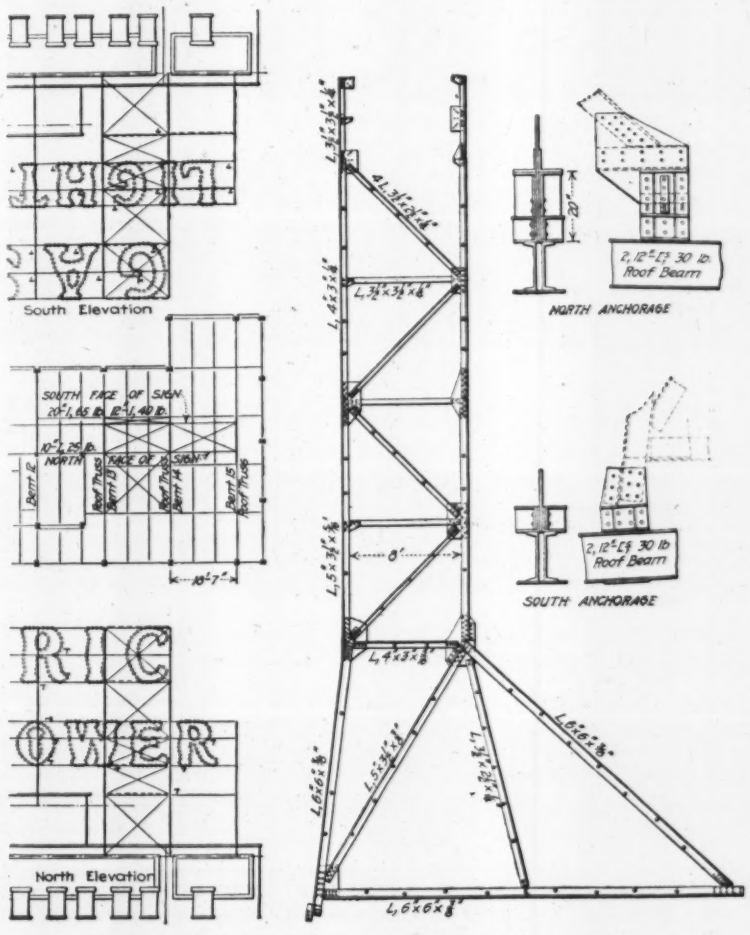
The framing of the small electric signs of former years was made up of small angles and flats, but with the building of signs of much greater dimensions this simple framework became insufficient and it was necessary to employ fabricated-steel structures, some members of which may be of considerable size. The increasing number and size of such signs brought to the attention of the late Mayor Gaynor of New York City the necessity for providing proper regulations and supervision for their erection. Acting upon the report of a committee appointed by him, the Board of Aldermen amended the Building Code during the early part of 1914 by adding sections relating specifically to sign structures. The first sign of such size to come within the purview of the new ordinance was the large structure which has just been erected upon the building of the Consolidated Gas Co. at 15th St. and Irving Place, New York City.

The structural-steel frame of this sign is 254 ft. long and 63 ft. high. The sign has two faces about 8 ft. apart, displaying to north and south. There are 28 galvanized-iron letters on each face, of which 11 are 15 ft. high, 14 are 12 ft. high and 3 are 7½ ft. high. The frame consists of 15 bents of various heights, depending upon whether one or two tiers of letters are carried, and whether the steel rises from the main roof of the building or from the three penthouses. The figure shows the layout of the structure. There are five tiers of longitudinal framing, each strut consisting of two 6-in. channels, and to these the letters are attached.

The structure is designed for a wind pressure of 30 lb. per sq.ft. over the actual exposure of the letters and framework, the wind being assumed as acting simultaneously in the same direction on each face. The lower portion of each bent is designed for the actual live and dead load applying to its particular location, but the upper portions of all the high bents were made to the dimensions of that bent having the maximum stress conditions. The horizontal and vertical reactions of the wind pressure at the feet of the bents were found to be of such amount as to require serious attention in designing the anchorages. In all cases these anchorages, of which there are 30, were attached directly to the existing steel frame of the building, the roof covering being cut away at all such points to permit the connection being made. The anchorage was flashed around with copper before the roof covering was restored. The existing steelwork of the building varied widely in character at the different points where the attachments were to be made; hence some of the anchorages are attached to a roof truss, others to the tops of columns and in one instance to a girder beam consisting of two 24-in. I-beams. Of the 30 anchorages, but few are duplicates, and all of them required careful detailing.

The sign contains about four thousand 10-watt tungsten lamps on a 119-volt circuit. The current is supplied by a single feeder which is carried up through a wire-duct to the roof, where it is subdivided into five branches, each of which is controlled by an independent switch. The main feeder is controlled by an automatic switch in the basement.

The sign was designed and erected under the supervision of the Engineering Department of the Consolidated Gas Co., William H. Bradley, Chief Engineer, and W. Cullen Morris, Engineer of Construction. The general contractor for the sign and its equipment was the Federal Sign System, which retained Homer A. Reid as Consulting Engineer. The subcontractor for the structural steelwork was the Earl C. Maxwell Co., Inc., of Brooklyn, N. Y.



TYPICAL STEEL FRAMING OF LARGEST ELECTRIC SIGN

Wire-Drag Surveys, by the U. S. Coast and Geodetic Survey at Key West, Fla., resulted in the discovery of about 100 shoals during the past season. The coral formation in this region produces many abrupt pinnacles of very small area, which it is impossible to detect with certainty with the sounding lead.

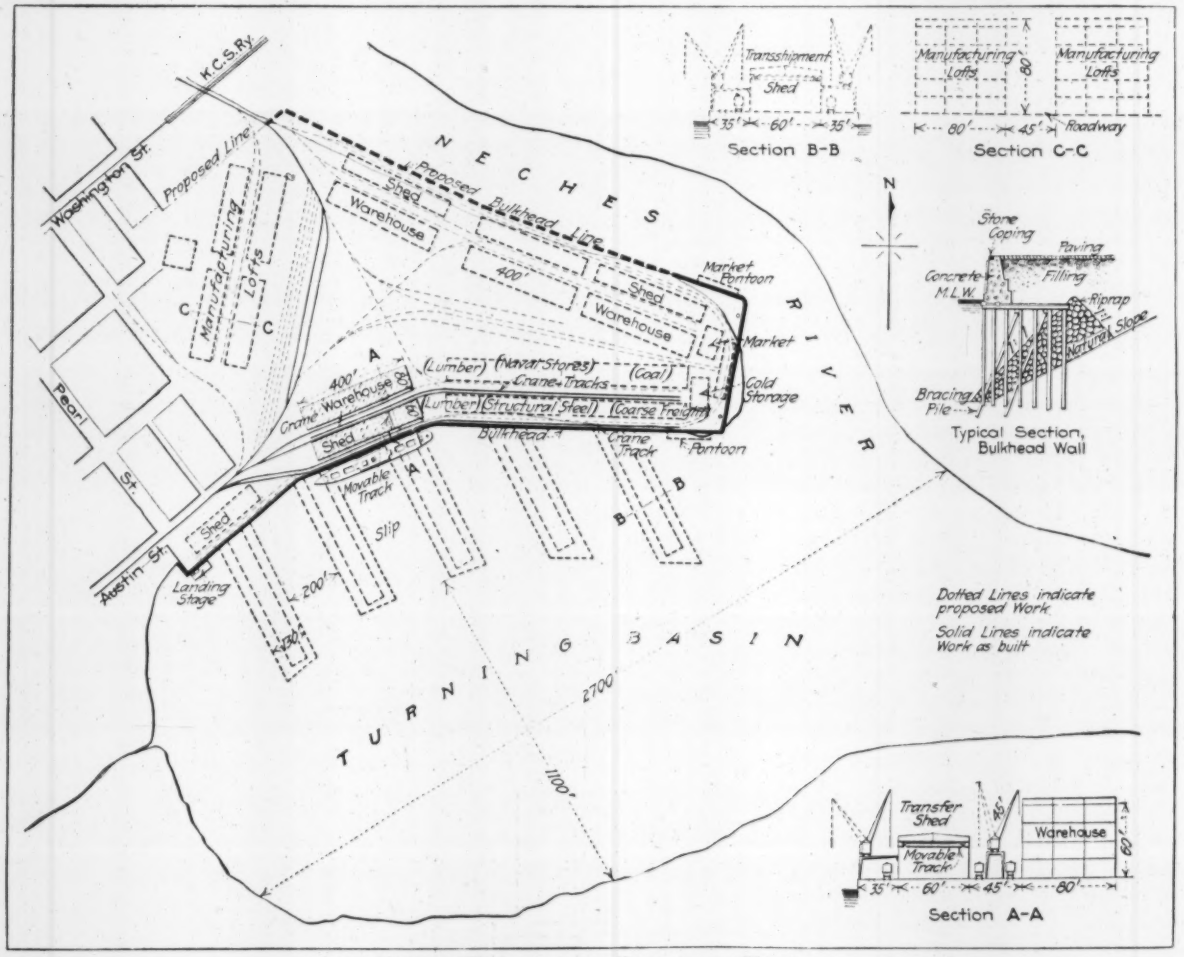
New Marine Terminals at Beaumont, Texas

By H. McL. Harding*

Along much of the coast of Texas there is little deep water, for the Gulf of Mexico at the coast is shallow, and generally for a distance of half a mile from the shore the depth at low water is not over 6 ft. There are, however, a few deep-water channels extending inland, one of which is the Nechez River. On this river, about 50 mi. from the Gulf of Mexico, is situated the city of Beaumont, with admirable railway connections and a harbor capable of effective improvement. At this city there has been organized a Wharf and Dock Commission, which, with funds procured from a city bond issue, is proceeding to the construction of port works to be owned, controlled and operated by the city. The accompanying drawing shows the project, with the work now under construction in full lines and the extensions as planned in dotted lines.

There is a channel about 25 ft. in depth from the Gulf to the quays of the city. A turning basin is dredged in front of the quays in the form of an oval, the dimensions being about one-half by one-third of a mile. For the new development the city was fortunate in being able to secure within a thousand feet of the Court House a large plot of land, called Kirby Point, around three sides of which flows the Nechez River. With the land and water areas there is available about 55 acres for an industrial or local terminal.

On the other side of the river, bordering partly on this basin, is another area, of hundreds of acres, of sufficient size for a commercial or through-freight marine terminal for all of Texas. Here will be established a large railway service yard, comprising the receiving, classifying and storage tracks, a transfer station, and large cotton, rice and other warehouses, both for outbound and inbound cargoes, as well as large open spaces for the storage of coarse and bulk freight not affected by climatic conditions. The dry docks of the port will be here.



Marine Terminal at Beaumont, Texas

(Full lines indicate work under way; dotted lines indicate projected work)

The Industrial Terminal, of which the plan and sectional elevation are here given, is designed to be constructed on the unit system. A unit length of quay is equal to 500 ft., which is the length of a large freighter, such a unit being provided with a proportional length of shed, warehouse, necessary railway tracks, and also the transferring and handling machinery. Thus a second unit can be installed without requiring any changes in Unit No. 1 or interruption of traffic.

Each unit complete, including the above-mentioned elements, with the dray area and the filling and paving, will make the total investment, without the land, about $300,000. The seven units, with the fish and farm markets,

*Consulting Engineer, 17 Battery Pl., New York City.

the cold-storage and administration buildings, the manufacturing lofts, sheds, railway-approaches and storage tracks, will require an investment of about $3,000,000.

The first unit, now under construction, comprises a bulkhead along the south, east and a part of the north shores of the point, a warehouse and shed with proper equipment, including extended railway and crane tracks, and lumber sheds east of the warehouse unit. The other units and the piers will be constructed as traffic demands call for them.

Traveling gantry jib cranes will transfer freight to the car, quay or shed. It will be assorted, distributed and tiered in the shed by overhead traveling hoists and movable tracks. By other cranes, which will be at the rear of the shed, freight is to be transferred by one direct movement from the shed to any story of the warehouse.

By means of the terminal railway tracks and the present Belt Line R.R., cars can be switched between any of the railroads entering Beaumont and any shed, warehouse or storage place within the terminal. Railway tracks are between the shed and the waterway and between the shed and the warehouse, thereby affording complete coördination.

For the present and future development of the industrial terminal there will be, besides the area mentioned, about 325,000 sq.ft. of pier space, 575,000 sq.ft. of slip space and 60 acres in addition in the turning basin. There will be 9275 ft. of linear frontage, over which, when mechanically equipped with the latest appliances, and intensively worked, there can be transferred annually more than 3,000,000 tons of miscellaneous cargoes.

The seven transfer-sheds on the quays and the five transshipment sheds on the piers will be of steel and will have a total holding or short-time-storage capacity of 114,500 tons. In the concrete warehouses there will be a long storage capacity of 150,000 tons. The open storage spaces for outside freight will amount to approximately 300,000 sq.ft. The concrete manufacturing lofts will have a combined floor area of 620,000 sq.ft.

There will be an administration building, farm and fish markets and a cold-storage building. Coal pockets and oil pipes are situated where vessels can be supplied with the least discomfort to the remainder of the terminal.

The principal freight movements will be between the vessel and the pier, quay, shed, car, dray or large motor truck, and also between the shed and car and the different stories of the warehouse, all of which movements will be effected by machinery.

The following are the characteristics of the traveling gantry jib cranes:

Two types of cranes, one a half arch and the other a full arch.
Normal load, 3 tons.
Over-reach, 45 ft.
Horizontal distance between crane tracks, 32 ft.
Maximum height of lift, 70 ft.
Lifting speed, 3 tons at 150 ft. per min.
Lifting speed, 1½ tons at 200 ft. per min.
Motive power, electricity, direct current, either 550 or 220 volts.

There will also be transfer bridges for lumber and structural steel and conveyors for special commodities. In the sheds will be overhead traveling, transfer cranes and electric traveling hoists, of a hoisting and carrying capacity of 2 tons each, for assorting, distributing and tiering of miscellaneous freight. The hoists will be operated in trains. For long movements, motor trucks will be used.

The quay walls above low water will be composed of concrete, as shown in the accompanying drawing.

Moment of Inertia of a Rectangle by Elementary Method

By William H. Gravell*

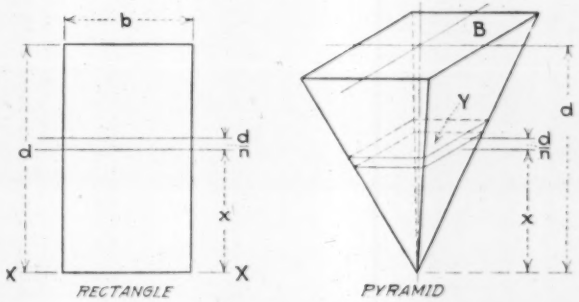
The following method of determining the moment of inertia of a rectangle about its base without the use of calculus was devised by the writer and used in teaching a night class made up of students who had no knowledge of calculus. Once the moment of inertia of a rectangle about its base is found, it is a simple matter to transfer it to the neutral axis, and by methods of symmetry to find the moment of inertia of a triangle and of a circle.

Let the breadth of the rectangle be denoted by b, depth by d; to prove $I_x = \frac{1}{3} bd^3$. Pass a number of lines through the rectangle parallel to the base, dividing it into n equal areas each equal to $\frac{bd}{n}$ and at the variable distance x from the base; thus x varies from 0 to d. When n is increased without limit,

$$I_x = \Sigma \frac{bd}{n} x^2 = bd \Sigma \frac{x^2}{n}$$

The problem is to find the value of the summation $\Sigma \frac{x^2}{n}$.

Consider a pyramid of altitude d with square base of area B. We know that its volume is $V = \frac{1}{3} Bd$, but we can also express the volume as a summation. Pass a number of planes through the pyramid parallel to the base, dividing the volume into n slices of equal thickness $\frac{d}{n}$ and at the variable distance x from the point of the pyramid, x varying from 0 to d. Let the base area of a slice be called Y. When n is increased without limit the



volume of a slice is $Y \frac{d}{n}$, and the volume V of the pyramid,

$$V = \Sigma Y \frac{d}{n}$$

But $\frac{Y}{B} = \frac{x^2}{d^2}$, or $Y = B \frac{x^2}{d^2}$, so that

$$V = \Sigma \frac{Bx^2}{d^2} \frac{d}{n} = \frac{B}{d} \Sigma \frac{x^2}{n}$$

Since we know that the volume equals $\frac{1}{3} Bd$, we learn that

$$\frac{B}{d} \Sigma \frac{x^2}{n} = \frac{1}{3} Bd$$

or

$$\Sigma \frac{x^2}{n} = \frac{1}{3} d^2$$

This value may then be used in the equation for Ix, since x, n, and d and the upper and lower limits of summation correspond exactly in the two cases. Therefore for the rectangle, $I_x = bd \Sigma \frac{x^2}{n} = bd \times \frac{1}{3} d^2 = \frac{1}{3} bd^3$

*1420 Chestnut St., Philadelphia, Penn.

New Municipal Asphalt Plant for Borough of Manhattan*

By Henry Welles Durham†

SYNOPSIS—Design of the new asphalt plant owned and operated by the Borough of Manhattan, New York City. Brooklyn has had a plant for some time, but the Manhattan plant was not put into service until the summer of 1914. It is located on the East River, with water approach offering a ready method of bringing in materials. The article gives details of design, operation and organization. Operating force under civil-service rules and regulations. Has largest capacity of any municipally owned asphalt plant in the world.

The new municipal asphalt plant of the Borough of Manhattan, New York City, has the largest capacity of any municipally owned asphalt plant in the world. It comprises several connecting buildings and a large yard, which is also used as a general storage yard by the Department of Public Works, situated on the East River waterfront between 90th and 91st St.

The plant layout is shown in the accompanying plan, Fig. 1. At the point marked *a* at the waterfront is located a steam hoist equipped with a grab-bucket of 40 cu.ft. capacity on a wood mast and boom. The hoisting machinery is a 10x12-in. double-cylinder engine with a double-friction drum. Steam is furnished by an 80-hp. vertical fire-tube boiler designed for a working pressure of 150 lb. In Fig. 3 is a view of the plant looking toward the river front. In the right foreground is the trestle railway leading up to the tower.

The material elevated is discharged into a hopper on a tower, which is located at the junction of three wooden trestles leading to bins where sand, stone and coal are stored. The material in the hopper on the tower is fed into small dump-cars of 40 cu.ft. capacity each, which are run to the bins by gravity and returned to the tower by counterweights. The sand and stone are dumped through hopper-shaped openings in the roof of the building into storage bins built of concrete walls and roof and located under the main roof of the building.

*From advance pages of a report of the Bureau of Highways, New York City.

†Recently Chief Engineer, Bureau of Highways, Borough of Manhattan, New York City.

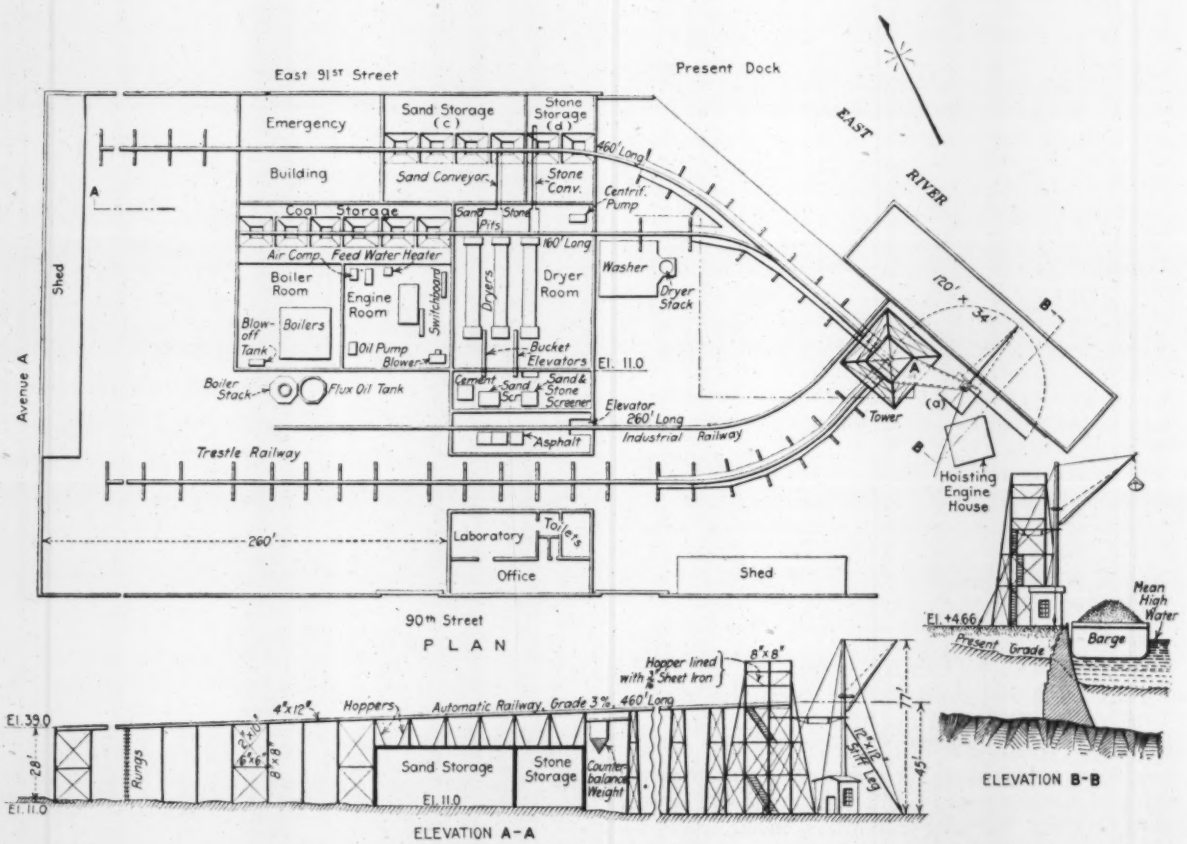


Fig. 1. Plan of the Municipal Asphalt Plant of the Borough of Manhattan, New York City

The sand and stone are fed to the top of the rotary driers, first by spiral conveyors, then by bucket conveyors. The material passes through the driers, is heated by forced-draft fires and discharged at the foot of bucket elevators, which convey the material to the hot sand and stone bins. These elevators are inclosed in steel sheeting as a protection against the weather.

The hot sand, when it reaches the top, passes through a rotary screen into the bin. Tailings are conveyed to the ground floor at the stone elevator, where they are rehandled and used in making binder or concrete. The sand bin has a capacity of 600 cu.ft., while the stone storage bin has 450 cu.ft. capacity. Hand-operated gates at the bottom of these bins discharge the desired amounts into weighing boxes.

DRIERS—There are three rotary-drum driers 24 ft. long, 5½ ft. in diameter, two being for sand and one for stone. Each may be operated independently. Space is provided for an additional drier. Each drier can dry and heat 15 tons of sand per hour to a temperature of 400° F., the sand being 50° F. with its present moisture. Each drum consists of a single steel shell, on the inner side of which are riveted twelve 6-in. channel irons.

The hot blast for these driers is furnished by a blower driven by a vertical high-speed engine located in the main engine-room. The discharge from this blower passes through a duct beneath the floor to the driers and is regulated by means of a damper in the ashpit of each drier furnace.

ASPHALT KETTLES—There are four asphalt melting kettles. Each has a capacity of 20 tons. Barrels of asphaltic cement are delivered from the waterfront and chopped into pieces at the foot of a platform elevator. This brings the material directly above the kettle, into which it is dropped.

At the bottom of each kettle is a series of steam coils 1¼ in. in diameter, giving 250 sq.ft. of heating surface. To bring the asphaltic cement to a temperature above 510° F. requires a steam pressure of 110 lb. Each kettle is provided with a pipe for agitation of the material by steam or compressed air, as is desired.

A line of 6-in. pipe extends from the water-front, where flux oil is delivered by tank barges to a 25,000-gal. storage tank, about 250 ft. away. This oil is automatically pumped to a weighing tank on a movable track over the asphalt kettles and is poured into them as desired.

The asphalt cement is discharged from the melting kettle through steam-jacketed pipes with quick-opening valves into a weighing bucket hung on a trolley, which receives the charges from any kettle and delivers it to either mixer. The sand and stone are weighed by a portable beam scale, which allows for tare, etc., so that no computations are necessary.

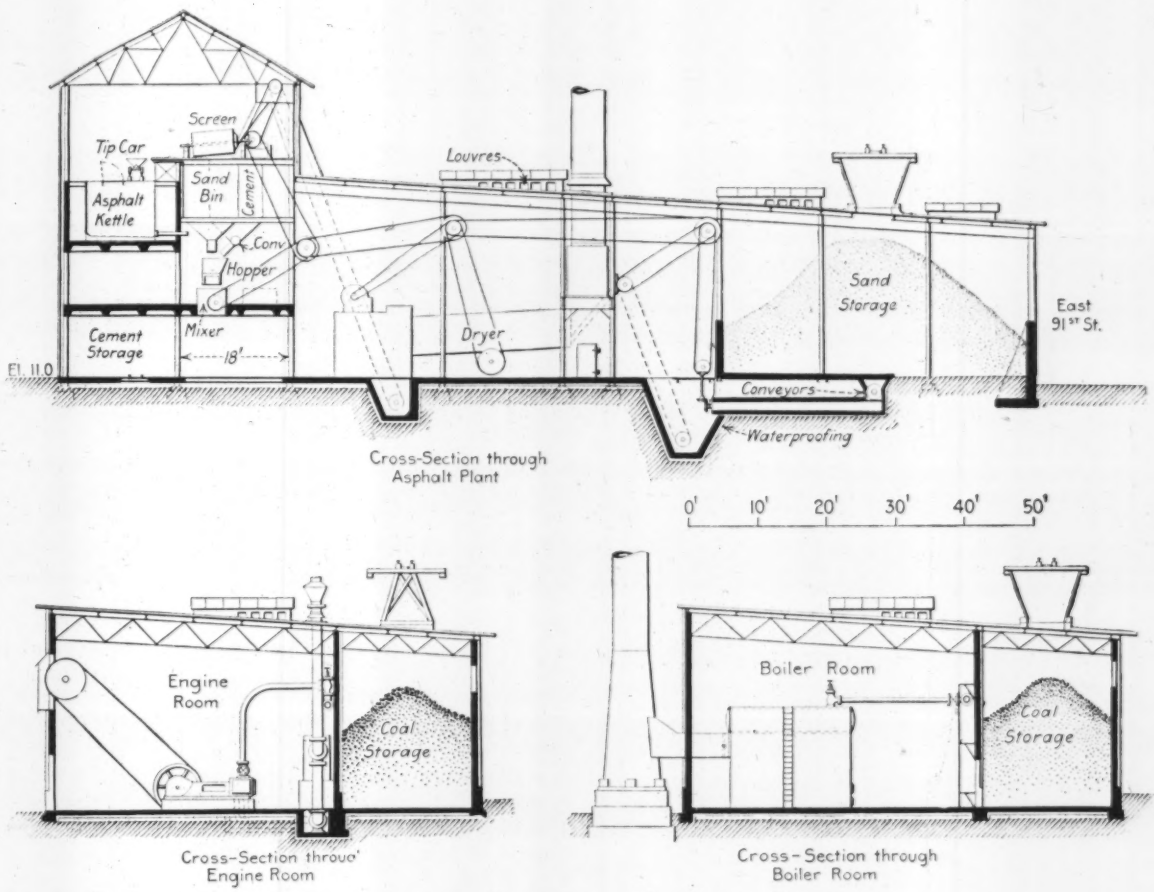


FIG. 2. CROSS-SECTION OF THE MUNICIPAL ASPHALT PLANT OF THE BOROUGH OF MANHATTAN, NEW YORK CITY

CEMENT, OR STONE DUST—A third bin is provided for the storage of cement, or stone dust. The material is delivered to this bin from the waterfront by the same elevator which conveys the asphaltic cement. At the bottom of the bin is a spiral conveyor controlled by a hand lever, which discharges as much filler as is necessary directly into the weighing boxes, which are located below.

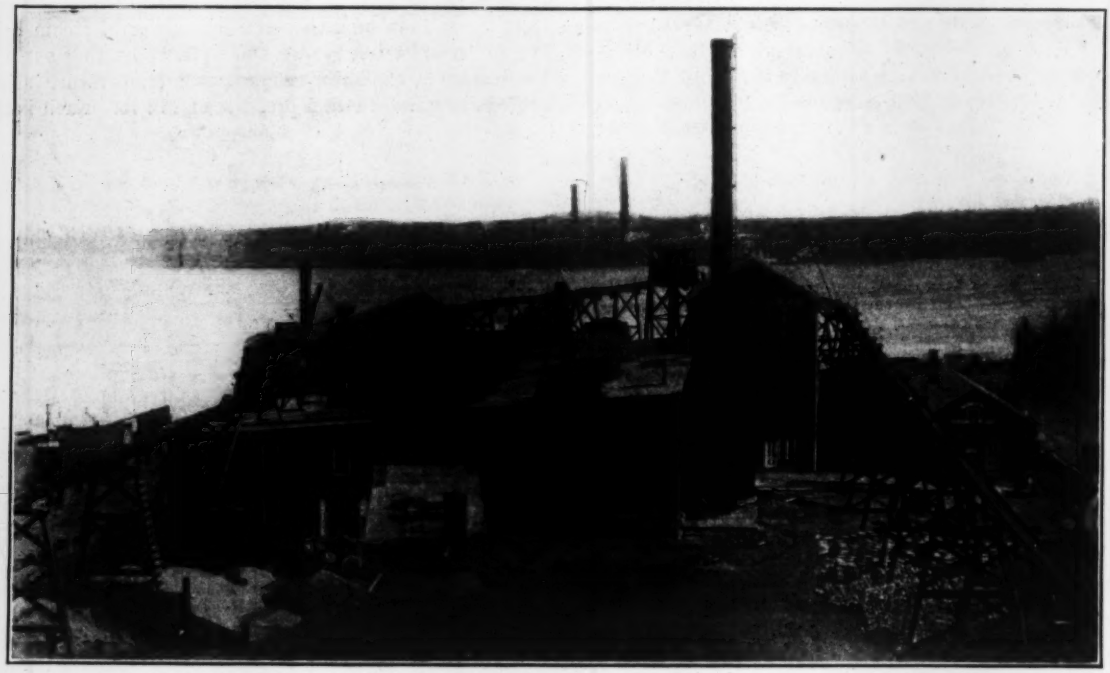


FIG. 3. GENERAL VIEW OF NEW YORK CITY MUNICIPAL ASPHALT PLANT

MIXERS—Sand, stone and cement are dropped from the weighing boxes into mixers of 16-cu.ft. capacity, each mixer being provided with manganese-steel blades. When

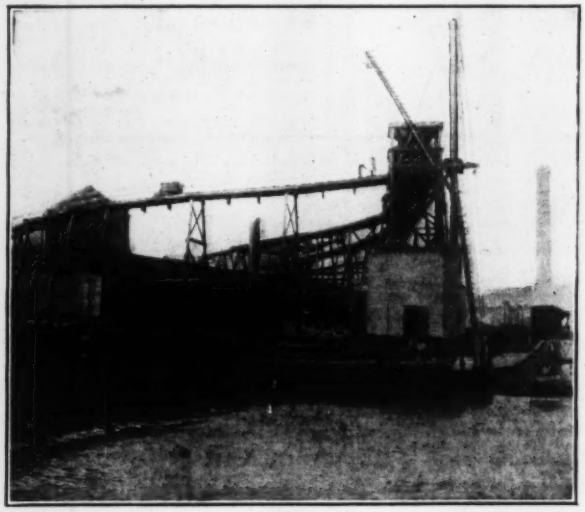


FIG. 4. PIER AND UNLOADING TOWER

mixed the material is discharged through a steam-operated gate in the bottom of the mixer into trucks directly beneath. The mixers are steam-jacketed, steam being supplied through reducing valves. The mixers are placed above the floor in order to save headroom and are directly in line over the driveway and so placed that two trucks may load simultaneously.

POWER PLANT—The plant is provided with two 150-hp. Babcock & Wilcox water-tube boilers, designed to carry 150-lb. pressure. The working steam pressure, however, is from 100 to 120 lb. These boilers are provided with a self-supporting stack 100 ft. in height. Forced draft is now being installed in each of these boilers, so that the cheapest grades of anthracite coal can be used with economy. Provision is made for an additional boiler should this be found necessary, if the plant is enlarged.

A horizontal Corliss 150-hp. engine is used to operate the plant. It drives the main shaft by an 18-in. belt and operates all the machinery except the platform elevator, which is run by an electric motor, and the blower, as already noted. An air compressor located in the main engine room is used to supply air for agitating heated asphaltic cement.

A horizontal 6x4-in. duplex pump is provided in the engine room for elevating the flux oil through a storage tank to the weighing bucket. The pump is provided with an automatic valve for starting and stopping as the discharge valves on the end of the air line at the melting kettle are opened or closed.

DUST COLLECTOR—Gases and dust from the driers pass through a horizontal steel flue and enter the top of a washing chamber, which is provided with a stack for the exhaust of gases and with baffle plates and piping, so that the dust and gases pass through sheets of water, which is pumped from the river by a centrifugal pump.

AUXILIARY MACHINERY—The exhaust steam and the condensation in the high-pressure coils are returned to a 200-hp. feed-water heater, through which they pass to a horizontal duplex feed-water pump. This water may be delivered to the boilers either by a steam pump or through injectors.

PYROMETERS—Temperatures of sand and stone and asphaltic cement are registered on automatic recording instruments placed in the office.

PLANT DETAILS—A building is provided for plant office and storage room. Shower-bath room, toilets and lavatories for the use of the plant employees are also provided, as is a separate office building for a chemist's laboratory.

The plant and yard are lighted by electricity, and a machine shop is now being installed to provide for the upkeep of motor tractors and trailers, which will be used during 1915.

The machine shop is now equipped with an 18-in. lathe, shaper, drill press, grinder and tools necessary to repair almost anything which may go wrong with the plant or automobile trucks.

ORGANIZATION—All employees of the plant were appointed in accordance with civil service rules and regulations. As the Brooklyn Borough plant had been in operation for several years the civil service commission had eligible lists for asphalt foremen, road roller engineers and asphalt workers. This made possible the quick assembling of a force with previous experience, facilitating organization and operation. One gang was sent into the field on May 25, 1914, and gradually more gangs were organized until a maximum of seven asphalt gangs and one concrete gang were working steadily.

The superintendent of the plant, who reports to the Chief Engineer, has reporting to him a plant supervisor in charge of the work at the plant, a gang supervisor in charge of the outside work and an office force.

The plant supervisor has control of all work at the plant. A stationary engineer, assisted by three firemen working in 8-hr. shifts, is in charge of the boiler room and engines, reporting to the plant supervisor.

A hoisting engineer, who has charge of unloading materials as they arrive at the waterfront and of keeping the trestle in good condition, also reports to the plant supervisor. A machinist, reporting to the plant supervisor,

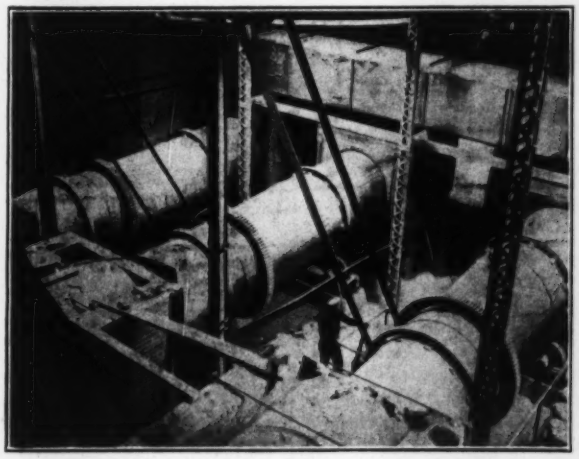


FIG. 5. DRUM DRIERS, NEW YORK CITY MUNICIPAL ASPHALT PLANT

is in charge of all oiling, blacksmith work, sharpening of tools, etc., and the maintaining of machinery in first-class condition. A mixer foreman, reporting to the plant supervisor, is responsible for the temperature of sand and stone as they go into the mixture, as well as for the mixing, loading and dispatching of the finished product.

A gang supervisor is responsible for the amount and quality of the work done by the street gangs, outlining the work from information obtained at the main office and by his own observation. He directs and is responsible for the transportation of material, and also controls the concrete foundation gang. Each gang consists of one foreman at $4.50 per day, one asphalt steam-roller engi-

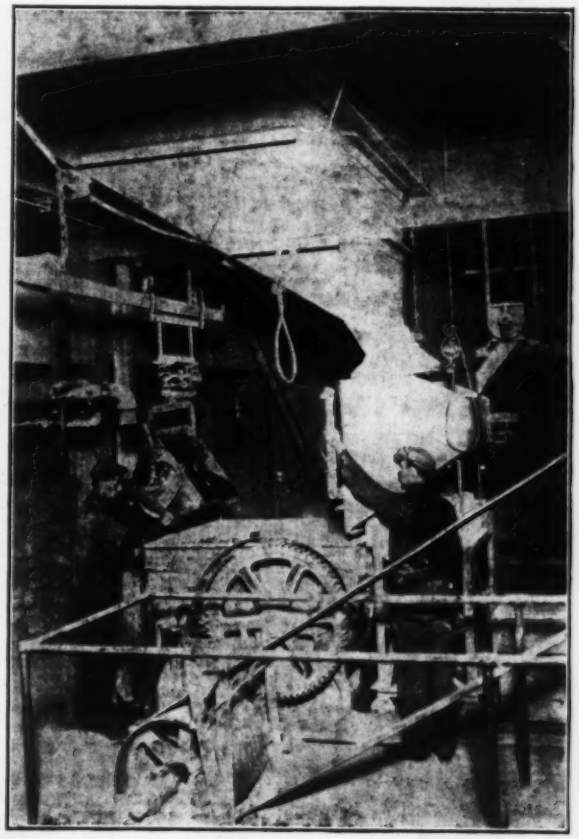


FIG. 6. MIXERS, NEW YORK CITY MUNICIPAL ASPHALT PLANT

neer at $5 a day, three watchmen at $600 a year, two rakers at $3 a day, two tampers at $2.80 a day, two smoothers at $2.50 a day, one roller boy at $2.50 a day, and seven laborers at $2.50 a day.

The minimum wage of $2.50 per day is in accordance with a resolution of the Board of Estimate and Apportionment.

The chemist reports to the chief engineer of the bureau direct and coöperates with the plant superintendent, thus bringing about the same condition of inspection as is the case with the asphalt companies. He takes temperatures on each batch before and after mixing, makes pats and penetration tests, notes sand and cement gradings, etc. Samples are also obtained on the street, which are analyzed at the main laboratory, thus affording another check on the character of the material going into the streets.

The office force consists of two clerks, who have charge of time sheets, tabulation of cost data, materials and tools and do the other clerical work necessary in the running of the plant. They report direct to the plant superintendent.

Field and Office

Concrete Plant for Barge Canal Lock

Lock 32 of the New York State Barge Canal, about five miles east of Rochester, is 45 ft. in width by 338 ft. between quoin posts. The walls are 25 ft. bottom width stepped to 5 ft. top width and are 45 ft. in extreme height. The structure contains about 24,000 cu.yd. of concrete.

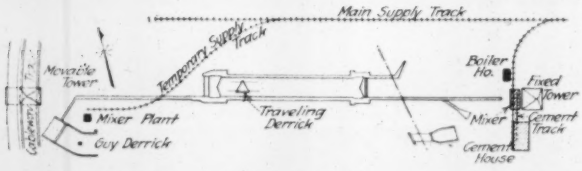


FIG. 1. CONSTRUCTION-PLANT LAYOUT OF N. Y. BARGE CANAL LOCK 32

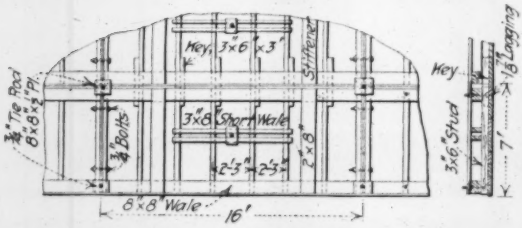


FIG. 2. FIRST TYPE OF LOCK-WALL FORMS

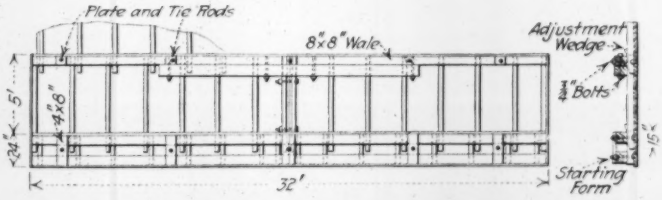


FIG. 3. FINAL TYPE OF LOCK-WALL FORMS

FIG. 4. SOUTH LOCK-WALL WITH EARLY TYPE OF FORM

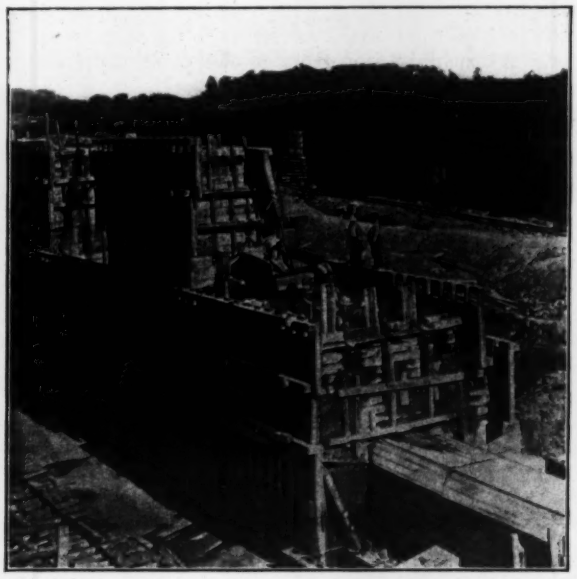


FIG. 5. NORTH LOCK-WALL WITH FINAL TYPE OF FORM

The main concreting unit was a cableway outfit, but while this was being erected a guy derrick was installed at the foot of the upper spillway and a temporary mixing plant put up. This plant handled all the concrete for the spillway and a few adjacent sections of the approach wall. As soon as the cableway was in operation this outfit was dismantled.

The cableway, installed by the S. Flory Manufacturing Co., Bangor, Penn., had a span of 1200 ft. and a capacity of 5 tons. It was carried by one fixed and one movable tower and was so placed that the normal position was on the axis of the south wall. This gave command of both approach walls as well as the lock wall without any movement of the tower. The towers were of 10x12-in. timbers, braced with 3x10-in. sticks. The lower tower was set in the lower level and was 52 ft. square at the base and 125 ft. high.

The movable tower was 95 ft. high and was built with an extended base to hold the operating machinery, which was placed on this tower to enable it to move by its own power. The tower was carried by 30 wheels traveling on six concentric lines of rail, and was moved by a set of blocks run to a deadman. The cableway was operated by a 10x12-in. double-cylinder double-tandem friction

drum and link-motion cableway engine and a 50-hp. locomotive boiler. The main cable was 2¼ in. dia. and the operating cables ¾ in.

The mixing plant was located immediately in front of the fixed tower in the lower level. The top of the material bins was at the elevation of the natural surface, permitting the supply tracks to run over them. Cement was transferred to narrow-gage cars at the point of delivery, and transported to the cement shed, which had a capacity of about 1000 bbl. From the shed the cement was carried to the mixer on small cars, which delivered it to chutes leading to the charging platform. The larger part of the gravel was brought in on the Erie Canal. A stiff-leg derrick operating a clamshell unloaded it from the boats either into a storage pile or into the cars supplying the mixer. The arrangement of the mixing plant permitted these cars to be dumped directly into the bins, from which the gravel was fed to the mixer by gravity. A 1-yd. mixer was used, power being furnished by a 50-hp. boiler, which also supplied steam to heat the aggregates in freezing weather. The concrete was handled in 2-yd. bottom-dump buckets.

Two types of panel forms were used. The first (Figs. 2 and 4), used on the south wall, was built up of 8x8-in. wales bolted to 3x6-in. studs, and 1⅞-in. lagging. To insure a proper alignment of the lagging, 3x6-in. keys were driven between the wales and lagging at the horizontal joints, and the end stubs on adjacent panels were bolted together to stiffen the vertical joints.

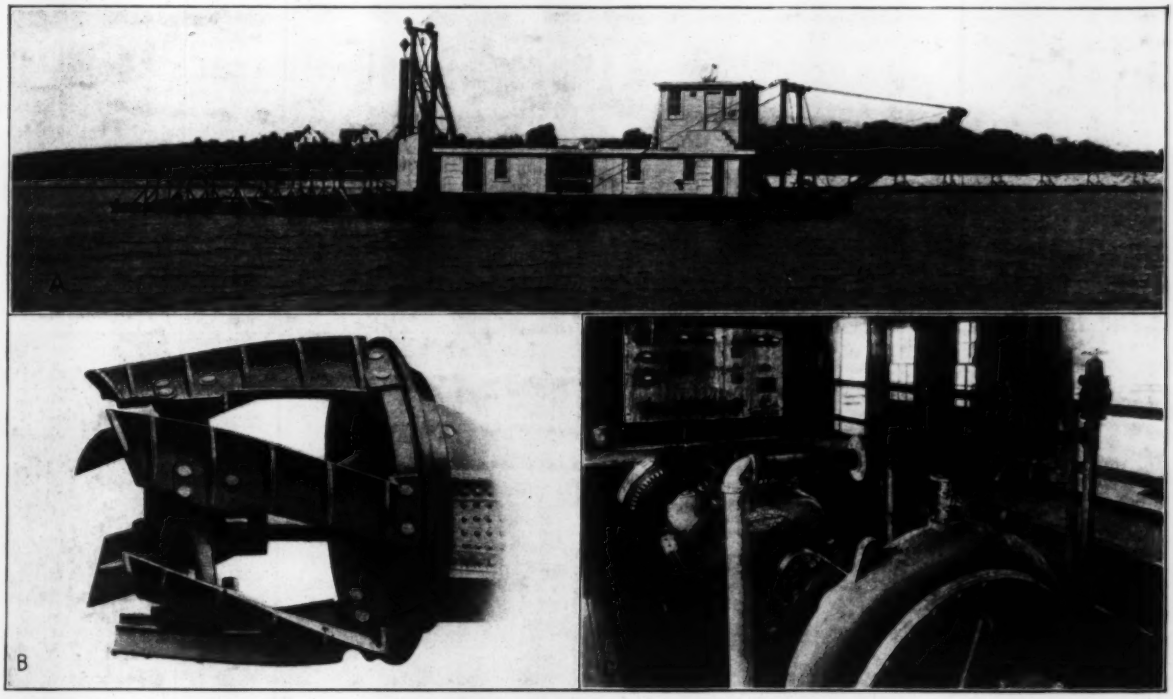
To maintain a good alignment with the type of forms proved difficult, on account of the vertical joints in the sections and the impact of the concrete falling from the rising bucket. As the wall was built in sections 26 ft. 8 in. long and the usual lift governed by the outline of the wall was 5 ft., it was decided, for the north wall, to splice two panels rigidly together and to cut down the height (Figs. 3 and 5). The lower wales were taken off and used to splice the two upper wales together. The lagging was cut to 5 ft. and the studs to 6 ft. 3 in., the projecting ends being tapered slightly. When the forms were put together this 15-in. length of stud projected below, between the lagging and wale of the form on which it rested. Exact alignment was secured by wedges driven between the studs and the wale. A small panel 2 ft. high was used to start the wall on.

The angle the cableway made with the north wall made it impracticable to use it in shifting forms from one section to another, so a derrick traveling on the lock floor was installed to handle the forms for that wall.

The work was carried on under the supervision of the State Engineer of New York; Milliard & Lupton, Philadelphia, Penn., had the contract covering this lock.

Pump and Cutter of Electric Dredge

The essential features of an electrically operated hydraulic dredge,* used on extensive filling-in work at Minneapolis, Minn., are illustrated in the accompanying views.



ELECTRIC SUCTION DREDGE, WITH CUTTER AND MAIN PUMPING UNIT

The main centrifugal pump is driven at two speeds—300 and 200 r.p.m.—by a 500-hp. synchronous motor running at 720 r.p.m. The cutting machinery and the operating and winding machinery are driven by two 30-hp. slip-ring motors.

Three-phase 60-cycle alternating current, at 2300 volts, is used on the motors without transformation. The dredge was built by the Norbom Engineering Co., Philadelphia, Penn., for the Northern Dredge & Dock Co.

*This dredge was described without illustrations in our issue of May 6, p. 889.

Safety Methods Used in Handling Explosives

The accompanying photographs show the methods in use at the quarry of the Riverside Portland Cement Co., Riverside, Calif., to minimize the risk of accident in handling explosives. The pictures, with the titles underneath them, explain clearly the methods used. It may be added, however, that besides the apparatus and methods shown in the pictures, the company has had a special case made with a closed top,

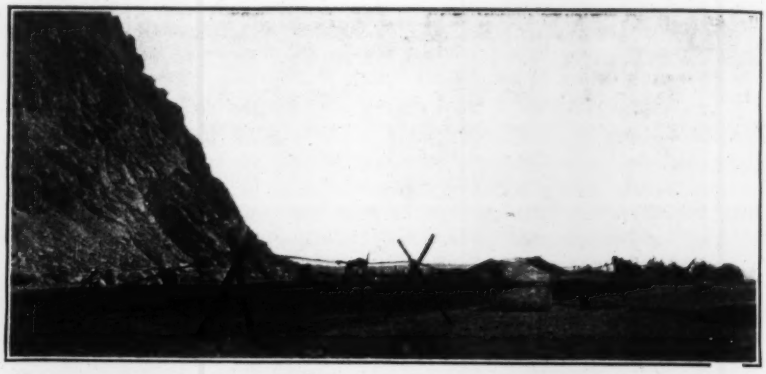


FIG. 1. BARRIERS AND SIGNS WHERE EXPLOSIVE IS BEING HANDLED

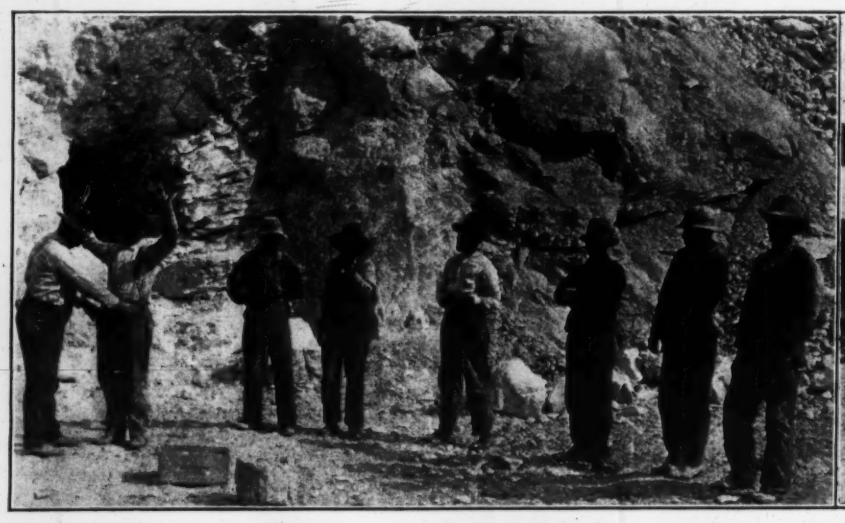


FIG. 2. SEARCHING THE POWDER GANG FOR MATCHES, KNIVES, METAL, ETC., BEFORE BEGINNING WORK

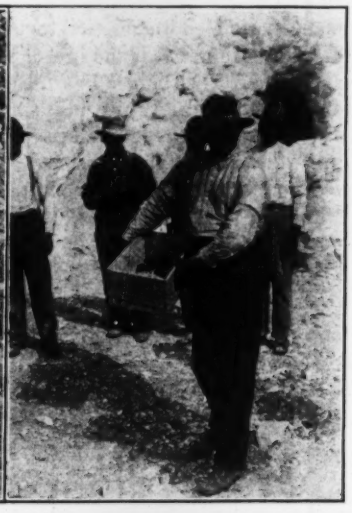


FIG. 3. ARTICLES CONFISCATED BY THE SEARCHER

FIGS. 4 AND 5. LEATHER CARRYING CASE WITH PADDED BOTTOM FOR FUSES

for carrying partly filled boxes of dynamite. It has also developed, for use in cutting dynamite cartridges, a knife which is made from an alloy soft enough so that it cannot produce a spark.

Recognizing that safety depends even more upon the care exercised by the men engaged in the work than upon

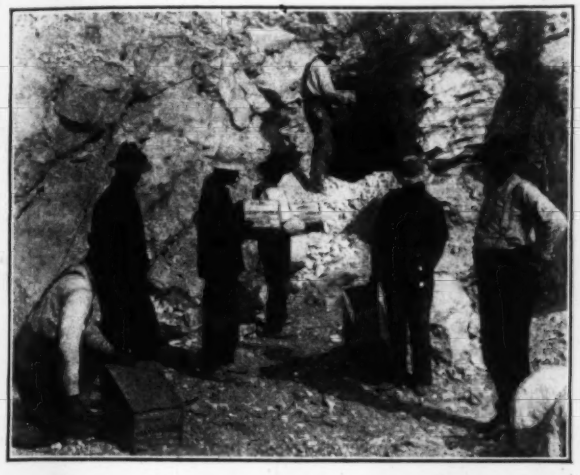


FIG. 6. PASSING DYNAMITE INTO THE TUNNEL
(A copper tool is used in prying off the box cover)

the appliances used, the company has inaugurated monthly meetings of its foremen, powder men and magazine men. At these meetings detailed methods for obtaining safety in all parts of the work are discussed and rules are formulated and adopted.

Diagram for Computing Rock in Sewer Trenches

BY C. A. BRYAN*

In the construction of the sewerage system at Carlisle, Penn., in 1913-14 much rock was excavated. The notes for the computation of this rock excavation made during

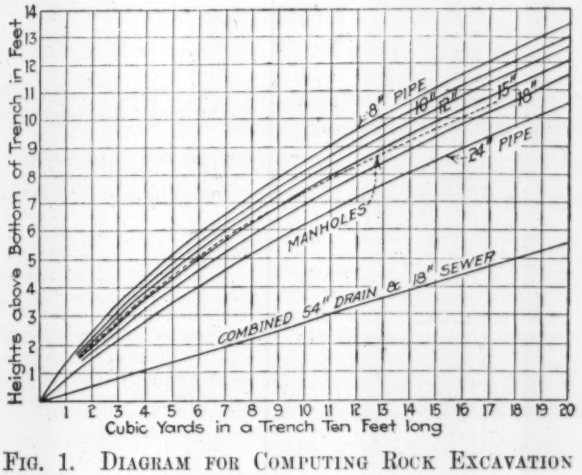


FIG. 1. DIAGRAM FOR COMPUTING ROCK EXCAVATION IN SEWER TRENCHES
(The original was on a 21x16-in. sheet of standard cross-section paper, ruled to inches and tenths)

the first month of construction followed the lines generally adopted for cross-section work and were figured accordingly. The computation of these notes proved a very laborious task, as it required from three to four days to compute and check the rock excavation finished during the first month. The accompanying diagram (Fig. 1) was therefore devised and was used for the remainder of the computations.

The following clause from the specifications describes the method of payment for rock excavation, and the diagram was computed in accordance therewith:

> Whenever rock is encountered in excavating the trenches, it shall be stripped of earth in sections not less than 50 ft. in length, and the engineer will then measure or cross-section the same. The contractor will be allowed 1 ft. wider than the outside diameter of the pipe at a point 4 in. below the bottom of the sewer, and from thence upward in the proportion of 1 ft. horizontal to 6 ft. vertical.

The quantities were then plotted on cross-section paper, using for abscissas the number of cubic yards in a trench 10 ft. long and for ordinates the heights of rock above the bottom of the trench. In determining heights above bottom of trench measurements were not referred to the invert of the sewer, but a reduction was made to allow for the thickness of the barrel of the pipe, depending upon the size used. One line was drawn representing the ex-

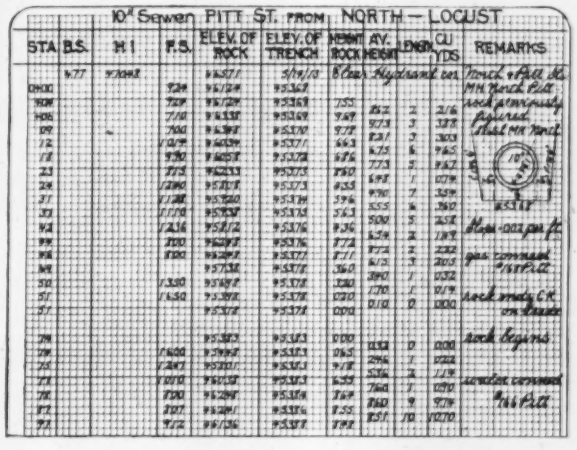


FIG. 2. PAGE FROM COMBINED FIELD AND OFFICE NOTE BOOK FOR ROCK EXCAVATION
(The original sheet was about 8x6 in., ruled to inches and tenths)

cavation for each size of pipe used on the work. The diagram was mounted upon cloth to prevent its destruction from hard usage.

From this diagram the yardage in a trench 10 ft. long and for a given rock height above its bottom could be read directly. In case the distance between the readings taken in the field happened to be greater or less than 10 ft. the quantity taken from the diagram could be properly corrected mentally.

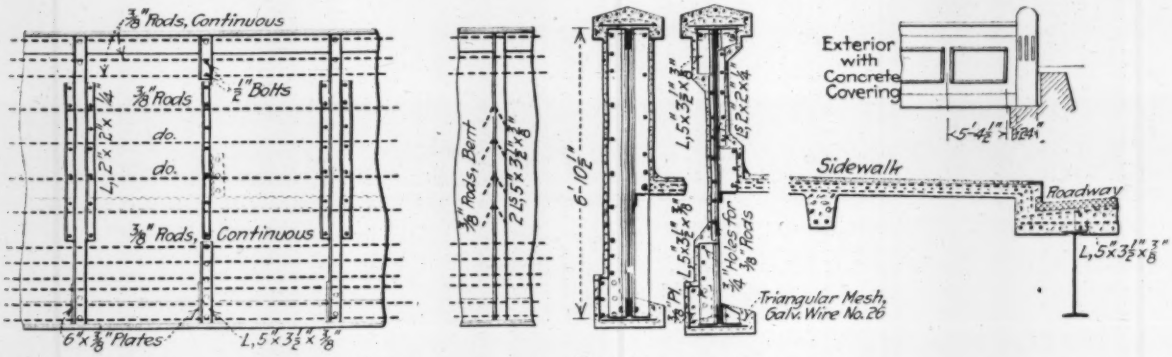
After some experimentation the field system was also changed. Keuffel & Esser's Cross-Section Book No. 376 was used, and the field notes were condensed so that enough room was left on the page to permit the office work being done on the same page. This did away with any mistakes that might have been introduced in transcribing the field notes from the field notebook to the office notebook; also, one set of notes sufficed for the computation of all rock excavation, and this resulted in the saving of a great deal of time. A sample page from the notebook kept is reproduced below and shows the field and office work combined on the one page.

*Resident Engineer, Sewerage Commission, Carlisle, Penn.

The writer found this system very efficient. Computation of the rock excavation for an entire month, and involving quantities as high as 1200 cu.yd., could be made and checked in less than a day. The only inconvenience found was due to the fact that the notebook necessary was too large to carry in the pocket and proved rather difficult to manage. However, the time saved more than compensated for the slight inconvenience.

Concrete Incasement of Steel Bridge Girders

A viaduct over the tracks of the New York, New Haven & Hartford R.R. in Pawtucket, R. I., carrying Barton St. and Broad St. over the railway, has its girders incased in concrete for decorative effect. The sketches herewith (from the railway drawings) show how the concrete is held on. Horizontal rods (⅜-in. square) through small angles alongside the stiffener angles of the girders and through additional 2x2-in. vertical angles between stiffeners—making the span of rods 1½ to 2 ft.—serve as supports for the concrete. The concrete being paneled, short bent rods are put through the outstanding leg of the stiffener angle to reinforce the pilaster of the paneling.



CONCRETE INCASEMENT, BARTON-BROAD ST. BRIDGE GIRDERS

The sketches show the arrangement of rods on the outside of the girders. The inside face is treated similarly above the reinforced-concrete sidewalk slab, while below the sidewalk the steel is bare. The I-beams (generally 18-in. and 24-in.) which support the sidewalk and roadway are left bare. Protection of the steelwork is not the object of the concrete incasement so much as appearance.

The bridge was designed by the railway company, under Edward Gagel, Chief Engineer (New Haven). W. H. Moore is Engineer of Bridges.

Water-Meter Pits, Milwaukee Water-Works

The standard place of installing water meters in Milwaukee, Wis., is in the basement of buildings, within 1 ft. of where the water pipe enters the building. Considerable difficulty has been experienced where there are no basements and provision had to be made for the outside setting of meters. Abandoned privy vaults and other unsatisfactory places had been tried, and in order to provide a standard outside setting the Superintendent of Water-Works, H. P. Bohmann, adopted the type shown in the accompanying illustration.

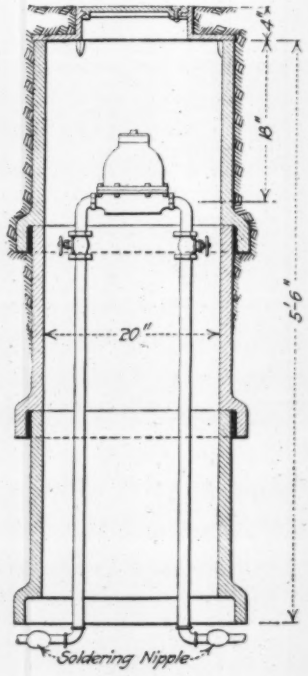
This is not a new design, for much the same method of installing water meters in Cleveland, Ohio, was described in 1902 by Edward W. Bemis (then superintendent of the Cleveland water-works) in his annual report (see ENGINEERING NEWS, Oct. 22, 1903, p. 373) and it has since been adopted in other places; but certain essential features are here emphasized.

Tests were made during the past two winters with ten such installations, in locations as different as possible, to find out if the climatic conditions in Milwaukee would cause any difficulty. These tests have been sufficient to satisfy the water-works officials that all outside meters should have this type of setting. In such installations Mr. Bohmann recommends that these points be borne in mind:

1. A testing valve should be provided on the outlet side of the meter so that the meter reader can readily determine whether or not the meter is registering. The present valve, for shutting off supply to premises when the meter is to be removed, can be so constructed as to serve this additional purpose.

2. Under certain conditions the small iron cover on these pits will become wet and dirty on the outside, owing to external conditions, and wet and rusty on the inner side owing to condensation of moisture. In the present form these covers must be handled to be removed and replaced, and it is practically impossible for meter readers to keep field notes and themselves in presentable condition. A locking device should be so arranged that the key, when releasing the locking bolt, will act as a handle whereby the cover can be removed and replaced without touching it with the hands.

3. These pits should be constructed so that the top of the small iron cover will be at least 1 in. above grade to prevent it from being covered with water and slush and freezing down. If set a trifle below grade, surface water finds its way on the cover, carrying dirt, etc., in suspension.

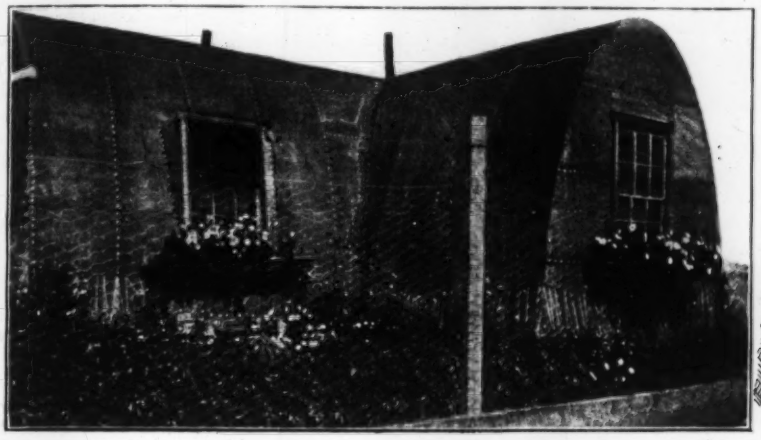


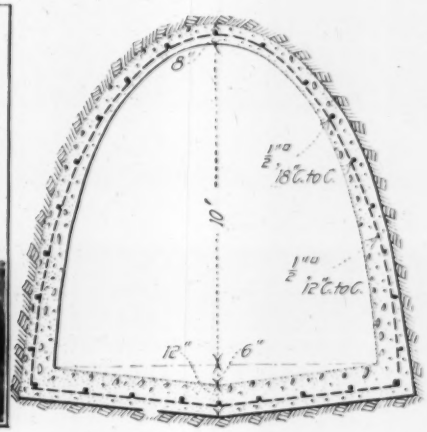
CLARK WATER-METER BOX

A Novel Office and Dwelling

During the construction of Delaney Fill, an embankment that carries the main aqueduct of the Turlock Irrigation District across a narrow cañon in California, an ingenious method of providing a dwelling and construction headquarters was adopted by Charles Harron, superindendent for the contractor.

Plans for the embankment required a concrete-lined culvert to carry storm-waters through the structure. The



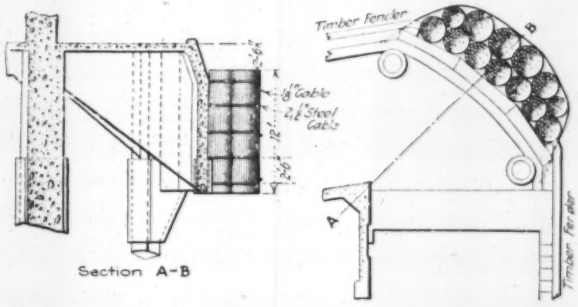


OFFICE AND DWELLING BUILT WITH CULVERT FORMS
(Conduit section on right)

section of the culvert is shown in the accompanying drawing. Extra culvert forms were utilized for the construction of the unique dwelling and field-office shown in the photograph. The house contained an office, two bedrooms, a living-room and a kitchen. The interior was finished in painted burlap and the exterior decorated with vines and plants, as shown. The structure was built by two men in half a day.

Willow Fascines for Pier Fenders

In the new Pier 2 for the Intercolonial Ry. at Halifax, N. S., bundles of willow or birch saplings, bound into fascines from 24 to 42 in. in diameter and 10 ft. long,



are tied together at each pier corner to form fenders. Each fascine was wound with ½-in. steel cable and those nearest the wall were tied back into it through openings left for that purpose; the other fascines were then tied to those so fixed and an encircling cable used to bind the groups back to the pier. The accompanying sketch shows the details of the construction.

Tile Drains Instead of Small Culverts on Highways

By F. O. Nelson*

We have had some experience in the use of tile drains as substitutes for small culverts in highway work. In beginning this work about two years ago we found many watercourses having small drainage areas combined with sufficient fall across the road to furnish an outlet for tile drains. Owing to the high cost of permanent culverts we recommended the use of such drains, with a fill of stone or of broken tile bats on the upper side of the road. We considered that the tile would remove the ground water even better than a culvert and calculated that for areas up to five acres (and not very hilly) the damage from washing would not be serious.

A number of these drains have been constructed and have given satisfaction. They have one important advantage that was not anticipated—the drains work better than small culverts during the spring while ice and snow still obstruct the culverts. Tile also offer less obstruction to the care of the roadsides.

We have some evidence that water from areas of much more than five acres of rolling land may be successfully handled in this way, at least when the adjoining land has tile drains. Farm drains are also utilized for outlets. In extensive tile drainage of flat and swampy lands, the exclusive use of tile with inlets instead of culverts may, of course, be carried to a far greater extent than for rolling and hilly land. With a deep fill forming a reservoir above the road, much flood water may be handled by these small drains.

We have used 8- and 10-in. tile, these sizes being common here. Their cost, for the small number used in each case, is not of much consequence as compared with smaller tile, and they are not so apt to become obstructed. About 100 ft. of tile for each place is generally used, running from the outlet across the road to the upper gutter, then turning and running along the gutter for about 50 ft. A yard or so of small stone or bats is used instead of refilling with earth at the low point in the gutter, no other intake or grating being used. We prefer the stone or bat fill for an intake, cost and all

*Civil Engineer, Toledo, Iowa.

considered. While a depth of 3 ft. or so is usually desirable in the upper gutter, we would not hesitate to construct them with a shallow covering when the outlet does not permit the deeper work.

The total cost, including a small concrete headwall at the outlet, should not generally exceed $20.

A Car-Lighting Generator Mounted on the Car Body

A new electric-generator outfit has been developed by the Safety Car Heating & Lighting Co., New York City, for its "axle system" of lighting railway coaches. Heretofore the generator has been mounted on the truck frame, but this introduced unsprung and overhanging weights, too heavy wear, and reduced the track clearances, etc. By putting the generator on the car frame, as shown in the

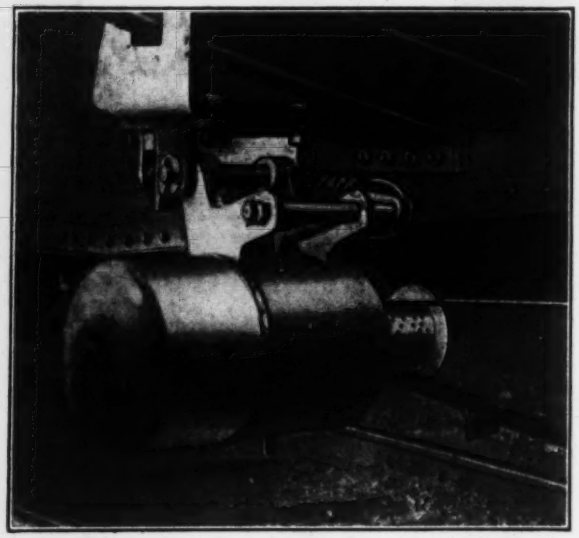
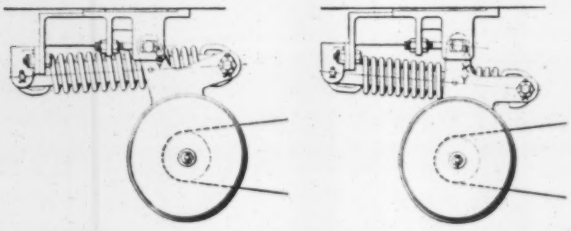


FIG. 1. AXLE-DRIVEN RAILWAY-CAR GENERATOR MOUNTED UNDER CAR FRAME

accompanying figure, it has been possible to use a higher-speed generator (through ability to use a smaller pulley), to decrease the total weight 60%, to increase the clearances, to decrease the wear and to increase accessibility.

The generator suspension is of unusual interest because of the means taken to secure constant belt tension in spite of varying angle between car and truck and varying distance between car axle and generator suspension. The



FIGS. 2 AND 3. ARRANGEMENT FOR KEEPING CONSTANT BELT TENSION

generator frame has cast on it two L-shaped lugs by which it is pivoted to the suspension frame. A helical spring on a carrier bar runs from a pin in the second arms of the lugs to a pin at the end of the suspension casting. In normal position (Fig. 2) the center of gravity of the generator hangs directly under the support and the belt tension is governed only by the spring tension. As the distance between car axle and suspension pivot increases, the generator is pulled forward; the leverage of the spring X in Figs. 2 and 3, however, decreases so that the belt tension (due to spring tension and generator weight) is constant.

NOTES

Culverts Under Sidehill Embankment—In staking out culverts on steep grades under embankments the following method of calculating the length may be new to some. Having decided on the grade necessary, find the center height between subgrade and top of invert. Suppose the culvert grade is to be 10%, the center height of the embankment 35 ft., the roadbed width 20 ft., and the side slope 1 on 1½; assume further that the plan shows straight wings and that the slope intersects the ends of the wings 2 ft. above the flow line or paving. On the lower end the distance from center line of embankment to end of wing will then be, in feet,

$$\text{distance out} = \text{half roadbed} + \frac{\text{net center height}}{\text{difference of slope ratios}}$$

$$= 10 + \frac{35 - 2}{0.66\tfrac{2}{3} - 0.10}$$

the terms in the denominator representing the slope of the bank and of the culvert. The corresponding distance on the upstream side will be found by using the sum of slope ratios in the denominator,

$$10 + \frac{35 - 2}{0.66\tfrac{2}{3} + 0.10}$$

If the wings are on an angle the distance should be figured for straight wings and the length of the wings figured from this. These formulas are approximate. To make them exact, add to the numerator in each formula the fall of the culvert in the half width of the roadbed, i.e., add the product of half width by culvert slope. In all cases except with very steep culvert slope this correction would be negligible.—J. W. M., Milford, Ohio.

Costs of Electric-Arc Welding for typical jobs in railway locomotive shops were given by G. W. Cravens, Manager of Welding Department, C & C Electric Manufacturing Co., Garwood, N. J., in a recent paper before the Southern & Southwestern Railway Club, at Atlanta, Ga. There was quoted $32 for repairing a broken locomotive-boiler mud ring (cutting out corner of plate, welding ring in place, welding back pieces of plate and driving a few new rivets) compared with $118 for the old method (stripping, removing ring for welding in blacksmith shop, resetting, replacing locomotive parts, etc.). Applying new fireboxes cost $56 (welding three short sheets) compared with $777 by the old scheme (stripping, transferring boiler, removing old firebox and building up new one, adding stay and crown bolts and mud ring, overhauling and refitting, etc.). With an outfit costing $2000, the following was done with current at 2c. per kw.-hr. and labor at 30c. per hr.:

	Welding	Old Methods
Mending both main frames	$11.80	$56.20
Driving wheel built up 3-16 in. on tread	2.72	8.00
General repairs on firebox side sheets.	66.51	342.62
Filling in worn knuckle-joint hole....	.75	7.50
Repairing seven cracks in cylinder casting	22.35	367.15

The following costs had no old figures for comparison:

	Time	Cost
Steel casting, shrinkage crack 1x6 in.	8 min.	$0.04
Forged-steel locomotive side-frame, two breaks	20 hr.	18.28
Welding 67 places in old firebox	12 days	52.60
Cast-steel tender frame, broken in three places	27 hr.	19.00
Cast-steel motor case, welded	3 hr.	1.95
Welding broken air-brake piston rod	30 min.	.35
Leaky axle box, crack welded without removing box	15 min.	.15

Nature-Study Methods in Railway Location—Field work has commenced in the course in railway curves. A special feature of this work, introduced recently by Mr. Hopkins with good results, has been the marking of the curves on the ground by means of white cord stretched from stake to stake. The stakes are also painted white. The result is that the student receives a good visual representation of the curve.—"Wisconsin Engineer."

Editorials

The Bureau of Franchises of New York City

New York City is unique among the cities of the United States, as far as we are aware, in having as a part of its municipal government a bureau charged with the special duty of investigating proposed franchise grants to corporations wishing to use the public streets. It is the duty of this bureau to so frame the franchise that the public will be assured of good service, the city treasury will receive some return for the use made of the street space, and yet the conditions will be such that the franchise-holding corporation can carry on its business successfully.

Probably few citizens of New York know anything concerning the valuable work that has been done by the Bureau of Franchises under its efficient chief, Harry P. Nichols, an engineer who has been long in the city service and who has been the head of the bureau since its establishment in 1905. The report of the bureau for 1914, recently issued, gives some interesting figures showing the results of the work with respect to the revenue received by the city from franchises which have been granted since the bureau's establishment.

We do not have to go back many years to reach a time when the idea of the city's gaining a revenue from the franchises it granted would have been greeted with derision by every practical politician. Probably " the great awakening" in New York City may be said to have begun in the '80's with the famous purchase of the Board of Aldermen by Jacob Sharp in order to secure the passage of a franchise for a street railway on Broadway. The exposure and punishment of that corrupt transaction was an object lesson to the taxpayers. Many perceived for the first time that if franchises were so valuable that a fortune could be spent in bribing aldermen to vote to grant them, then under an honest city government those receiving the franchise would be willing to pay their money to the city treasury instead of to corrupt city officials.

A further object lesson in the same direction was the enactment by the state legislature, during the administration of Governor Roosevelt, of the Ford franchise tax bill, under which corporations holding public franchises were compelled to pay taxes on the assessed value of these franchises.

When this public awakening occurred, however, the city had already parted with most of its valuable franchises. Railways had been built in nearly all the principal traffic streets, and the network of gas pipes and electric wires already covered the whole city. The Bureau of Franchises, therefore, could deal only with the new and comparatively unimportant franchises, yielding comparatively little profit from which the city could claim a revenue.

Notwithstanding this, during the nine years from 1906 to 1914, inclusive, the franchises which have been granted by New York City under the advice of its Bureau of Franchises have yielded a total revenue to the city treasury of $813,500. Most of this revenue, moreover, has been received in the last four years. The receipts from these franchises during the years 1906 to 1909 were comparatively trifling. In 1914, however, the amount collected was $156,000. Without doubt the income from these franchises will continue to increase rapidly year by year. The very proper policy of the Bureau of Franchises is to make the payments to the city required by the franchise comparatively small during the first years of a company's operation, when it is establishing its business and is subjected to many heavy expenses, but increasing in later years as the company's business becomes established and its earnings grow.

It would be a mistake, however, to measure the value of the service rendered to the city by the Franchise Bureau solely on the basis of the revenue which the city treasury receives from the franchises which the board has drawn. Much more important in the framing of a franchise are the provisions it contains insuring the rendering of good service. This feature alone has justified the work of the Franchise Bureau.

The important point to which we wish to call the attention of every student of municipal government is the assignment of the work of franchise investigation and drafting to a permanently organized bureau. In most cities the investigation and framing of franchises are left to some committee of the aldermen or council. There are thus no continuing policy with reference to franchise grants, no systematic records as to the franchises previously granted and their returns, and no organization equipped and competent to frame a franchise in the proper manner. In nine cases out of ten, so far as we are informed, the practice in most cities is to leave the framing of a franchise to the attorneys of the corporation applying for it. Unless the lawyers which the city may temporarily employ on its own behalf are expert enough to know what a franchise should or should not contain, all sorts of improper provisions are likely to be embodied in franchises so granted.

Successes and Failures of American Engineering Schools

We have previously noted the broad survey of engineering education which the Carnegie Foundation for the Advancement of Teaching, together with seven national engineering societies, has undertaken (see ENGINEERING NEWS, Apr. 20 and May 20, 1915). If these investigations result in a good answer to the first two questions which the Foundation has put to the practicing engineers of the country, the key to many vexing problems will be revealed. We believe that this key is already in the hands of some of our educators and, if we may anticipate the studies of the Foundation, a general description of

it is not difficult and is given by answering the two questions noted.

The Foundation asked, first:

What are the particular points at which the work of the engineering schools is effective and successful?

Where the American technical schools are successful in developing young engineers it is in the work of imparting to them certain fundamental knowledge and certain special training. The knowledge imparted comprises the elements of science, language, mathematics, mechanics, mechanism, properties of materials, drawing and laboratory procedures and some very rudimentary ideas of engineering practice. The training which is secured has for its object the development of a habit of thought and a method of problem-attack which arrays all the available evidence, weighs it impartially and then forms conclusions as the evidence dictates.

The second question asked was:

What are the particular points at which the work of the engineering schools is least effective and successful?

The obvious answer to this follows from the reply given to the first question. Engineering schools are least successful when they attempt to make their students engineers by giving them extended and detailed instruction in special lines of engineering practice which may be as well or better learned in the field and office. When this has been done, apparently it has come from an effort to introduce practicalities. Yet evidences multiply that the instruction too often fails to couple up to practical construction and operation.

One of the frequent criticisms of American technical schools is that so many enter and so few graduate. A scrutiny of the "mortality" figures shows that the schools have not yet found out how to eliminate the unfit early in the course, or rather to distribute quickly the men fitted for various careers. The instructors and student advisers are not doing as much as it is possible to do in such vocational guidance, although this is a work which properly can be begun in the preparatory-school period. At the present moment the tendency of this work in this country seems to be toward reliance on professional advisers and bureau organizations. But less skilled observers, such as parents and high-school teachers, often may secure as good results, for only broad distinctions in aptitude are yet feasible and long-continued observation and intimate acquaintance may offset the special experience of a "vocation director."

A warning may be given here concerning some of the attempts to degrade the movement for vocational guidance by those who as a commercial matter are advertising instruction in the art of switching people to the occupations for which nature destines them by observing the color of the hair, the length of the ears, the shape of the nose and similar superficial signs. The whole scheme much resembles the old pseudo-science of phrenology, and has been properly condemned by scientists.

What we look for from the Carnegie Foundation and the societies associated with it in investigating engineering education is not merely a statement of what we already realize—that our engineering education must be simple and fundamental and that our candidates must exhibit aptitude—but a presentation of ways in which simplicity may be attained, fundamental ideas kept practical, scientific habits of thought developed, and proper bents discovered.

Why Not More Engineering Competitions?

The success of the occasional competition for the academic solution of some engineering problem leads one to inquire why such competitions are not held oftener. In the vicinity of New York within the last year or so two of these contests were held with satisfactory results. One competition noted in these columns about a year ago was for a proposed method of restraining beach erosion at Brighton Beach, and the other, noted in the news columns of this week's issue, is for a solution of the traffic problem at 5th Ave. and 42nd St. in New York City.

In the architectural field such competitions are an established part of the educational system; not only are they used in the college, where, as a rule, a certain number of awards or mentions are required before a degree is conferred, but the practice is continued through the earlier years of professional life under the auspices of local or general architectural societies. The mental stimulus of a contest, the prospective honors to be gained, and the actual study required for the solution of an ideal problem all combine to make the method a lively, and, at the same time, desirable way of developing the young professional mind.

In engineering circles it is quite possible that the idea might at first be frowned upon because in the wider professional fields such competitions have not proved either desirable or successful. The ease with which a superficial design may catch the eye of a lay jury, the economic loss resulting when a number of engineers spend much valuable time on a problem which only one of them will be able practically to solve, and the difficulty of presenting in a limited space or with few drawings the solution of any complicated engineering problem—all have led to general disapproval of the engineering competition as a method of selecting an engineer for any particular work. But the principle would be entirely changed in the case of simpler problems, the solution of which is intended only to cultivate the younger professional mind or the selection of which is so carefully made as to make judgment as to superiority of any particular design quite easy to the technical jury which is examining the submitted plans.

The idea is certainly worth consideration by the various engineering societies.

Civilian Engineers for Military Service

As noted in the news columns of ENGINEERING NEWS of May 27, the American Society of Civil Engineers has taken the lead in endorsing the movement, started some months ago, for the organization of a reserve corps of engineers to be available for the country's defense in case of war.

The world has had an object-lesson during the last ten months that modern warfare is dependent on machinery and organization quite as much as on fighting men. An army in the presence of a foe would be quickly destroyed if it were deficient either in its transport organization or in carrying out the work of field fortifications.

The United States has in its entire army only 212 engineer officers. Most of them are engaged on purely civil engineering work, in connection with river and harbor improvements. A number are too far advanced in years to be expected to do active service in the field. A larger number are recent graduates from West Point, with very little experience. How hopelessly inadequate this small force of engineer officers would be to meet the emergency of actual warfare needs no demonstration.

This is apparently realized by the army officers themselves, and General Leonard Wood has taken a great interest in the movement to organize a reserve corps of civilian engineers whose services would be promptly available to the country in case of need. No better material could be found anywhere than among the field engineers of the United States from which to organize a corps of men fitted to enlist and train recruits in the engineering work of military operations.

The preamble to the resolution adopted by the American Society of Civil Engineers last week stated that "the membership of the society includes men seasoned in all lines of organization, creative and construction work, who are closely in touch with the great body of workers from whom the best grades of the rank and file of all branches of military service can be drawn."

While the civil engineers would form the very best material for recruiting the field force to carry on fortification and transport work, mechanical and electrical engineers would be equally valuable in organizing and training men to handle the various classes of machinery essential in warfare, from the field artillery to the automobile transport and the aëroplane scouts.

It is fair to ask what could be done with this reserve force when it is organized. The idea doubtless is that those joining it would hold themselves ready to respond to a call to service in the event of war. It seems to us, however, that the movement ought not to stop there. The engineer—civil, mechanical or electrical—while he has ability and experience, both in handling men and in dealing with machinery and materials, knows, as a rule, little or nothing concerning the particular applications of engineering in warfare.

To enable these men to render valuable service whenever called on, they should be given systematic instruction in military matters. A month's training would be of great value; three months would be far better, and if the task were really undertaken in as intelligent and thorough manner as would be the case with any of the military nations of Europe, a full year's training would be given.

Suppose Congress at its next session were to appropriate a million dollars to give experienced civilian engineers training in military work, granting them during the period of training the rank and pay of a second lieutenant, and at the end retiring them to civil life with the agreement that for a certain period—say ten years—they would be subject to call to receive commissions as officers and to train recruits in the event of war.

Estimating the pay and subsistence of men under such training at $2000 per year, an appropriation of $1,000,000 would give three months' instruction to 2000 men or a year's instruction to 500 men. If this were continued systematically for a number of years the nation would soon have a valuable body of reserve officers, experienced in organizing and directing men and able at all times to undertake the training of recruits for the army.

Congress will be likely to undertake any such scheme only as its merits are urged by civilian organizations. We see no reason why this proposed reserve corps of engineers should not take the lead in presenting to the proper committees of Congress this plan for making the corps an efficient instrument for national defense.

Letters to the Editor

Hydrated Lime in Concrete

Sir—In ENGINEERING NEWS, Mar. 11, 1915, an abstract of the report of W. F. Childs, Resident Engineer under the State Roads Commission of Maryland, states with reference to the use of hydrated lime in road concrete: "Apparently the hydrated lime has a tendency to reduce the effect of temperature changes, and thereby to prevent cracking."

It would seem that increasing the density of the pavement slab would have a tendency to *increase* the effect of temperature changes. The theory is advanced that the expansion and contraction of concrete pavement is due more to variations in the water content of the concrete than to variations in the temperature. I wonder if it has occurred to the men interested in these roads that what the lime really did was to waterproof the concrete, preventing variations in the water content, thereby preventing expansion and contraction and the resultant cracking.

T. H. JOHNSON.

Sioux City, Iowa, May 20, 1915.

Selling Water by Meter

Sir—An editorial note in your issue of May 6, 1915, implies that the sale of water by meter is advisable under all conditions. Portland, Ore., may be in an uncommon class, but the facts in connection with its water-supply appear to me to prove that in this case, at least, the general use of meters would be a refinement resulting in economic waste and an unwarranted burden on the smaller consumers.

Two pipe lines bring pure water from a distance of 30 miles, the new one having a capacity of 43,000,000 gal. per 24 hours. The maximum consumption is about 30,000,000 gal., and at all times water is wasting over the spillway at the headworks and over the spillways of the city distributing reservoirs.

A bond issue of $500,000 is proposed in order to meter all services, of which a large proportion are for small families and cottages, in which experience has shown that the consumption is nearly always less than the minimum charge of 75c. per month, or $9 per year. To meter

such services the cost of meter and reading per year, amounting to at least $1.50, represents an additional cost for the same amount of water to the small consumer of over 16%, while water is wasting at the spillways.

Some sections of Portland, owing to rapid growth, find the mains too small to maintain a proper pressure at times of general sprinkling, and although these sections have probably less than 10% of the consumers, this is used as the main argument for meters. The metering of large consumers is already provided for. Under these conditions it would seem that metering small consumers would be an economic waste. To rely on meters to materially increase pressure where mains are too small can only imply a restriction in the legitimate use of water, which is especially to be condemned when a large part of a gravity supply is wasted at the spillways.

GEORGE RAE.

34 Jefferson Ave., Brooklyn, N. Y., May 17, 1915.

[Neither water waste nor selling water by guess can be justified, because for the present the volume of supply is ample. The future as well as the present must be considered. Plenty of water is no guarantee that supply and distributing mains will not be or are not already overtaxed, as witness the fact that Portland had to duplicate its supply main some years ago and finds pressure inadequate in parts of the city today.

The argument against selling water by guess rests largely upon the absurdity and unfairness of the practice. The cost of meters for domestic consumers is small and a careful adjustment of the expenses of a public water-supply between the general public and private consumers, combined with a proper system of meter rates and ready-to-serve charges, will impose only a light water bill on the careful users while making the careless user and waster pay the cost of his own folly.—EDITOR.]

Patented Cantilever vs. Gravity Retaining Walls

Sir—The bids on retaining walls along the banks of the Sandusky River improvement in this city made on Apr. 20 are of more than usual interest, as they show the relative cost of plain concrete and reinforced-concrete retaining walls.

The city asked for bids on both types of walls of dimensions shown on the accompanying sectional drawing, the total length being 3200 ft. There were 23 bids submitted. The lowest complete bid on the plain concrete design made the cost of the walls $5.75 per cu.yd., or a total of $46,718.75, while the lowest bid for constructing the reinforced-concrete wall was $6.12 per cu.yd. and 2½ per lb. for the steel reinforcement, or a total of $31,476. The contract was awarded for reinforced walls. The price for constructing the plain concrete walls was 48% more than for the reinforced.

Of 17 of the bids on both types of wall the average price for plain concrete was $6.117 per cu.yd., while on the reinforced type the cost averaged $7.456 per cu.yd. for concrete and 2.77c. per lb. for steel reinforcement, the average cost of construction of the plain concrete wall being over 32 per cent. more than the reinforced wall, although the latter, as the drawing shows, is theoretically more stable both as to overturning and sliding, and the pressure on the toe is less per square foot.

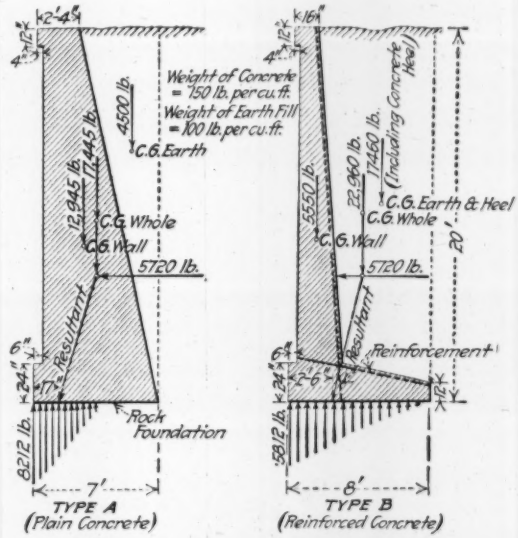
A higher grade of concrete was specified in the reinforced wall. If the proportion of cement had been the same in both walls the difference in cost would have been at least 7 per cent. more than it was, in favor of the reinforced walls.

J. I. OBERLANDER, City Engineer.

Tiffin, Ohio, May 7, 1915.

[Previous to the receipt of the foregoing letter we received a communication from a contractor who went to Tiffin with the idea of bidding on the retaining wall there, but for various definite reasons (not for publication) did not do so. His letter, a part of which follows, is an interesting commentary on the whole question of structural patents.—EDITOR.]

Sir—In a small river-improvement job recently advertised at Tiffin, Ohio, there was 3200 ft. of concrete retaining wall, for which there were offered as alternative sections a cantilever reinforced-concrete type and a gravity plain concrete type. Previous to the advertising for bids, an engineer who holds a patent on a cantilever reinforced-



COMPARATIVE RETAINING-WALL SECTIONS

concrete retaining wall offered to sell to the city of Tiffin for $1200 the right to use his patent on a wall. This offer was declined and the City Engineer designed what he considered a little different type of wall and put a clause in the specifications notifying prospective bidders that they would have to protect the city against patent claims. The patentee, however, claimed that the new design infringed his patent and notified contractors that he would charge 63c. per cu.yd. for every yard of concrete put in on that design. In the wall in question there was about 4100 cu.yd. of concrete.

The patentee then put in a bid on the work himself, which I figure would give him a 63c. differential over a fair bid for the contract. When the bids were opened there were several bids very near his and some were under. Whether the contractors ignored him and his patent or forgot to account for the royalty in the bid is a question, but there is no doubt that if he can collect the royalty he will make much more out of the job than would any one of the six lowest bidders had any one been awarded the contract.

CONTRACTOR.

Reconstruction of Austin, Tex., Masonry Dam

By Frank S. Taylor*

SYNOPSIS—The large masonry dam across the Colorado River at Austin, Tex., built in 1893, failed under heavy flood on Apr. 7, 1900, a section 500 ft. long sliding, almost intact, downstream. This article describes reconstruction just completed. New work comprises hollow reinforced-concrete section replacing length washed out, automatic crest gates, specially controlled sluiceways and a new power-house installation, the last to be described in a later article.

In the ten years after the failure of the Austin, Tex., dam in 1900,† a number of schemes were proposed for its repair, but nothing definite was done until 1910, when the city entered into a contract with a private company for its reconstruction. Designs for this new development were begun early in 1910 and the work was finally started in 1911. With the exception of a period from April, 1913, until January, 1914, the work has been continuously prosecuted since that time.

The old masonry dam was 1091 ft. long, a gravity ogee section with its crest 60 ft. above low water and about 70 ft. above rock bottom of the river. It failed under an overflow head of 11 ft., a central section about 500 ft. long being pushed out horizontally. Much trouble had been experienced with the foundations of the dam, which were of a shaly limestone interspersed with cracks and cavities, and the reservoir behind the dam had diminished in volume owing to heavy silting which had taken place.

After considerable study of the situation, it was decided that the new development could be made best and most cheaply on the same site as that of the original dam. While the foundation work for the new dam was more costly than it would have been if the location had been changed upstream some 800 or 900 yd., this expense was more than counterbalanced by the ability to use the exist-

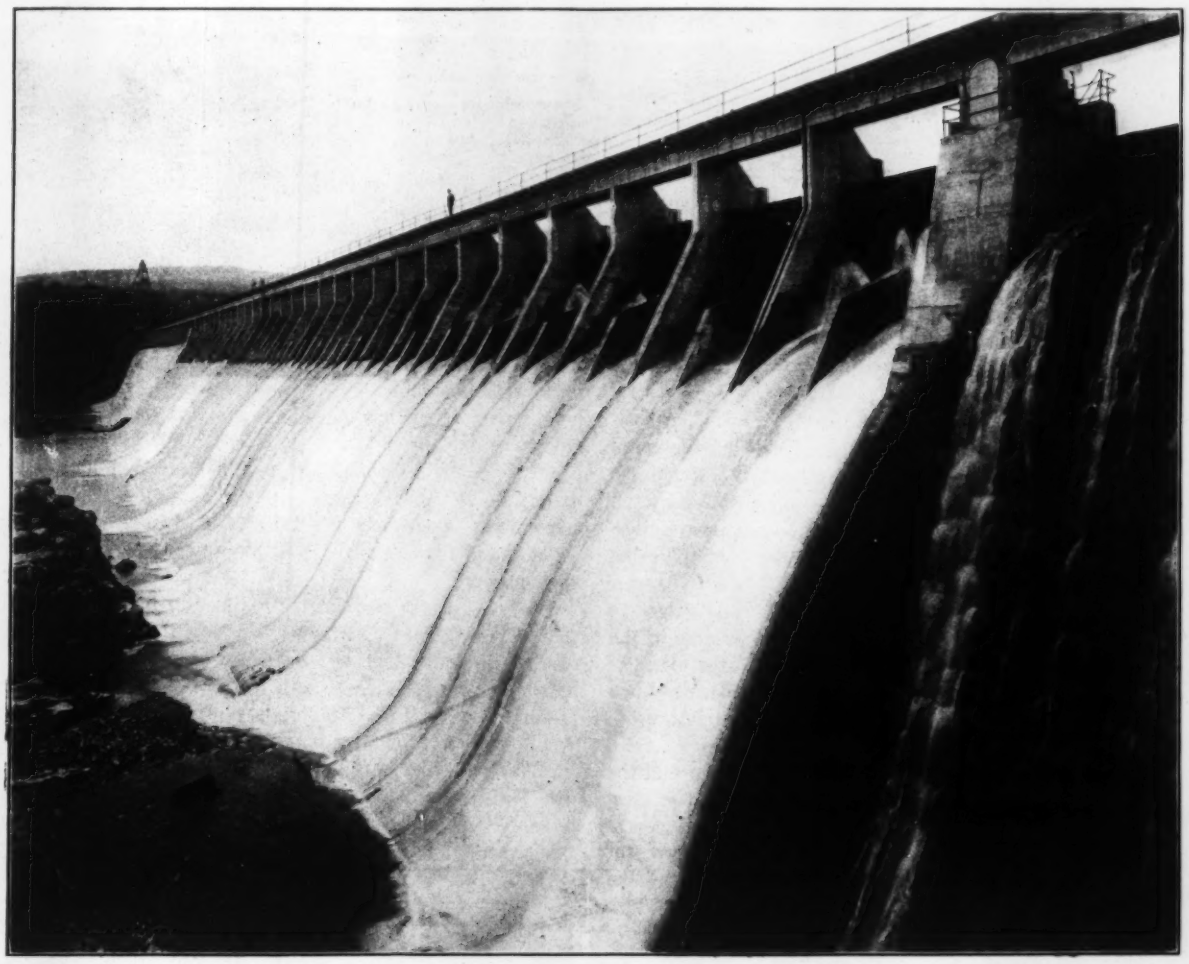


Fig. 1. The Reconstructed Austin Dam

*Recently engineer in charge of construction of the Austin Dam, Austin, Tex.

†See "Engineering News," Apr. 14, 1910, p. 440, for a list of nearly 50 references to the failure.

ing section, which comprised 520 ft. length of dam in good condition and on satisfactory foundation, together with all the bulkhead masonry, which was thoroughly good, though not on proper foundation. Also, the larger portion of the old power house, still standing, could be utilized. The most suitable character of structure with which to fill the gap was decided to be a hollow reinforced-concrete dam with a cutoff wall on the upstream side.

In order to get the proper amount of power and lake storage, the height of the water level would have to be raised from the old elevation of 60 ft. to 65 ft. above low water. That portion of the old section which had given way failed under a 71-ft. elevation of the water level, and it was imperative that the portion remaining and which would form a part of the new dam should not be again subjected to as great stresses as it had previously withstood.

It appeared as if these two conflicting conditions could not be reconciled. However, after considerable study, the arrangement of crest gates later to be described was

The river bed and the whole surrounding country are underlaid with limestone, which has many crevices, seams and cavities at varying depths below the surface. About 12 years ago, two U. S. Government engineers made a short report for the City of Austin, in which they gave an adverse opinion concerning the character of the river bottom for supporting a dam. About six years ago the city had a number of borings made to definitely determine the character of the river bed. It was then found that there were considerable amounts of broken limestone, soft limestone, cavities, seams and fissures underlying the dam, and the records obtained from these borings proved that in order to build a dam across the river at this point the defects in the strata underlying it would have to be corrected. It was decided to fill all the underlying seams and cavities with grout, and on the reconstructed river bed to build a hollow dam of reinforced concrete of such form that there could be no uplifting force from any leakage of water under it. Furthermore, as a portion of this new section, a cutoff wall would be sunk in a trench cut in the

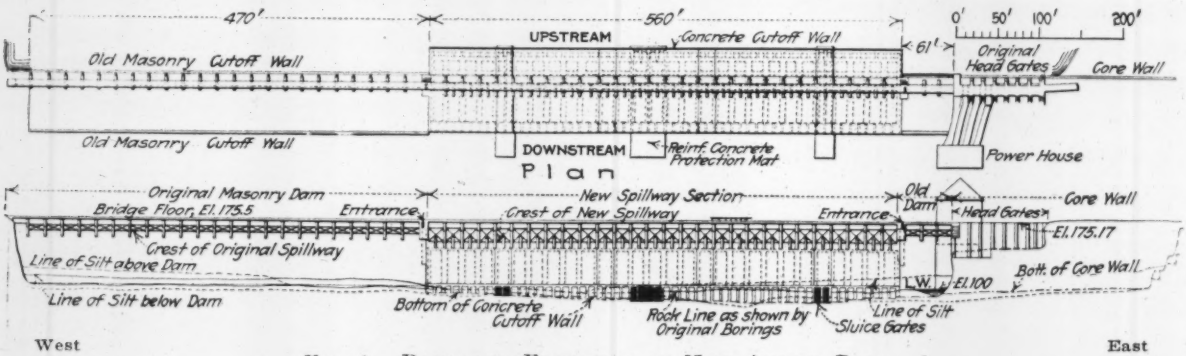


FIG. 2. PLAN AND ELEVATION OF NEW AUSTIN DAM

adopted. With this arrangement, the new section of dam was built only 51 ft. high from low water to crest, or 9 ft. lower than the old. Piers were built 20 ft. apart on both the old and new sections, the upper levels of the piers being the same over the whole length of the structure. Crest gates were placed between the piers, those on the old section being 6 ft. high and those on the new section 15 ft. high, so that their upper edges are all at the same level, which is 66 ft. above low water. When the water level is at an elevation of 65 ft. or less the crest gates are tightly closed. An increase of 6 in. in the elevation of the lake level will make the gates automatically overturn, letting the water flow out over the crest of the dam. When the level has fallen 12 to 15 in. or about down to the 64-ft. elevation, the gates automatically close.

During periods of flood the crest gates are open and the greater portion of the flood water is taken over the crest of the new section. It is estimated that with a discharge of 200,000 cu.ft. per sec., the thickness of the water over the crest of the new section will be 18 ft., the thickness of the water over the crest of the old section being 9 ft. This means that the present dam will pass 50% more water than passed over the old dam's crest when it failed, but the elevation of the water is only 9 ft. above the crest of the old dam, while it was 11 ft. above the crest when the weak section went out in 1900. The depth of the water below the low-water elevation varies from 5 to 20 ft., so that the total depth of water behind the dam varies from 70 to 85 ft.

rock on the upstream side and carried to such a depth that its lower edge would be below all permeable strata. The longer part of the old masonry dam, that on the western side, was not protected by a new cutoff wall but was grouted beneath through the test holes which had been drilled on the upstream side of the section. The downstream test holes were left open as indicators of possible leakage and to release any possible upward pressure from such leakage.

The unit pressure adopted for the wall footings was 12 tons per sq.ft., with a few walls where this pressure was carried up to 14.4 lb. per sq.ft. Wherever the rock was hard and firm for a depth of 4 ft., it was considered satisfactory to resist these bearing pressures.

Trenches were cut in the rock to receive the wall footings, and in the bottoms of these trenches, at intervals, drill holes were made 4 ft. in depth. Wherever these drill holes passed continuously through solid rock, the trench was accepted as suitable to receive the footing. Wherever the rock was hard but a cavity was encountered, grout was forced into the cavity and allowed to harden before the footings were built upon it. Wherever soft and defective stone was found below the bottoms of the building trenches, the excavation of these trenches was continued until some point was reached below which the thickness of the good rock was at least 4 ft.

The cutoff wall was carried, in many instances, a considerable depth below the footings of the buttresses. This wall, which is on the upstream side of the old east ma-

sonry section and the new concrete section, but not the old west masonry section, was poured in a trench that had previously been tested by numerous drill holes made in the bottom, and such defects as were found were remedied by grouting. These test holes were first made 12 ft. apart in the bottom of the trench. Compressed air was turned into them, one by one, to discover whether or not there was any underground connection between adjacent holes.

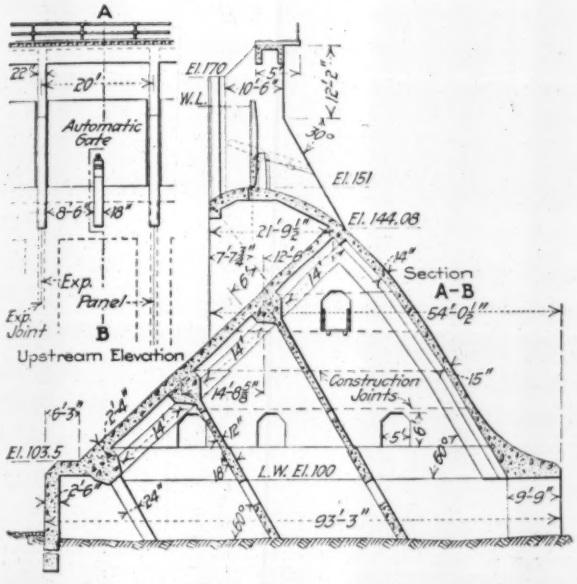


FIG. 3. DETAILS OF NEW REINFORCED-CONCRETE SECTION OF AUSTIN, TEX., DAM

Wherever the compressed air in entering one hole would blow out of one or more of the others, it was considered that the seams or crevices between the two holes were reached by the drill holes then made. Grout would then be forced into one of the holes until it began to blow out of the others. It was then considered that the rock lying below the cutoff wall trench and extending between the holes through which grout had entered had been made water-tight. Wherever no connection could be established between the holes 12 ft. apart, intermediate holes were drilled, thus making the drill holes only 6 ft. apart along certain portions of the cutoff wall trench.

In nearly every instance where these holes were made water flowed freely through them, sometimes spouting up 3 or 4 ft., thus proving connection between the holes. As grout would be forced into the holes, the velocity of water flowing out of them would gradually diminish, until it would entirely stop. In many cases, where grout was forced into a hole, the flow of water through other grout holes, sometimes as far distant as 50 ft., would be stopped and the grout would finally show, rising out of adjacent holes, proving that the underground seams between these two holes had been thoroughly filled with grout.

The grout used consisted of one part portland cement to two parts sand, mixed with sufficient water to form a practically liquid mixture. It was forced into the holes under a final pressure of 80 lb. per sq.in.

Subsequent to the completion of the work, a coffer-dam was built on the downstream side of the river and pumped out, and all leakage observed. There was practically no leakage through the foundation, or through the strata below the cutoff wall.

DESIGN OF REINFORCED-CONCRETE DAM SECTION

The total length of the reconstructed dam and corewall is 1535 ft., of which 1091 ft. is spillway (with 470 ft. of old masonry on the west, 560 ft. of new concrete section and 61 ft. of old masonry on the east), 144 ft. bulkheads, and 300 ft. corewall (Fig. 2). A typical section of the new part of the dam is shown in Fig. 3. As indicated, it is a reinforced-concrete structure, having an inclined upstream wall, making an angle of 42° to the horizontal. At a point about 2½ ft. above low-water level, this slope of the wall ends, intersecting a narrow horizontal bench, and from the upstream edge of this bench a vertical wall goes straight down into the rock and forms both the lower portion of the deck and the cutoff wall.

The object of the bench is to allow flow of water through any completed section of the dam during construction, the flat horizontal slab, which runs the entire length of the dam and covers the upper part of the bench, being omitted until the completion of the work. Normally, during construction the total flow of the river was taken through the sluice gates in the bottom of the dam, but during floods the openings through the horizontal bench, together with the area afforded by the sluice gates, would usually take care of the whole river flow, with an elevation in the water level of not more than 4 to 6 ft.

The supporting walls are both longitudinal and transverse. The latter are parallel to the flow of the stream and are 20 ft. apart. The longitudinal walls are also 20 ft. apart, measured from center to center in a direction at right angles to them, and are inclined at an angle of nearly 90° with the upstream deck. Their slope is such that the resultant of the forces which they resist, made up of the water pressure acting against the surface of the deck and the gravity component of the deck and the walls themselves, has the same direction as that of the longi-

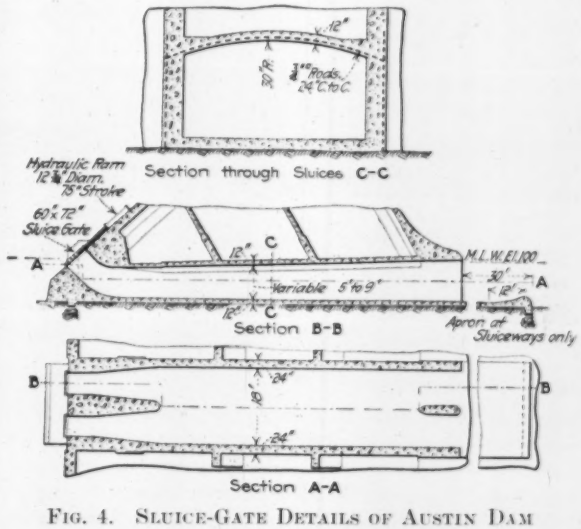


FIG. 4. SLUICE-GATE DETAILS OF AUSTIN DAM

tudinal walls. The longitudinal and transverse supporting walls intersect at right angles and form a series of square openings when viewed in a direction normal to the deck in which the reinforcing steel is placed both longitudinally across the length of the dam and transversely up and down the deck, the bars being laid closer and closer together as they get nearer and nearer to the middle of each panel.

All of the steel used was rerolled twisted bars having an elastic limit above 55,000 lb. The stresses allowed in the steel were 16,500 lb. per sq.in. maximum.

Owing to the difficult character of the foundation it was desirable to make the distance through the bottom of the dam, measured from the upstream to the downstream side, as short as possible. As shown in the typical section, Fig. 3, the spillway was designed in accordance with the usual method and the sloping deck made to intersect it about 25 ft. further downstream and 6 ft. lower vertically than in the customary design. By this method a proper length of theoretically designed spillway was made available, as well as an inclined deck of substantially the total height up to the spillway, and at the same time the length through the dam from front to back was reduced about 25 ft., diminishing in a like proportion the length of the transverse walls and the length of each transverse wall foundation, and eliminating one longitudinal wall. While the saving in material and labor, due to this form of design for a given factor of safety, was greatly reduced by the adoption of this design, the cost of the formwork was increased so that the net saving effected, though considerable, was not so great as would at first appear.

As indicated in Fig. 3, the vertical transverse walls intersect the deck and the spillway, continuing above them in the form of piers, on the top of which are placed reinforced-concrete girders that carry a railway crane-track. Between these piers are placed the automatic crest gates. In the masonry sections these piers are of the same design with the vertical reinforcing bars extended down into the old masonry.

All the concrete used for making the deck and cutoff wall was rendered waterproof by an admixture of hydrated lime in the proportion of 8 to 10 per cent. (by weight) of the cement, the proportion being varied with variations in the voids in the aggregate. This has proved to be thoroughly satisfactory, as were also the tests made of it prior to adopting it as standard construction on the work. The concrete mixture used was approximately 1:2:4. The proportions were fixed by making tests of the voids in the sand, stone and gravel. The proportions would be changed whenever the percentage of voids in these materials would show any change. Void tests were made every hour or oftener if indicated as mixing proceeded. River sand and some river gravel were used for the other constituent parts. Most of the aggregate, however, was broken hard limestone.

Expansion Joints

An ample number of expansion joints is provided in the new concrete dam, every fifth panel being an expansion panel. There are 28 panels in all. The expansion panels have both the upstream deck and the spillway entirely separated from the adjacent portions of deck and spillway on either side of it. A joint is made between the two abutting edges of the concrete slabs, which is water-tight, but which permits lateral movement of the different sections of the dam without diminishing the tightness of the joint or rupturing any of the masonry. This joint is made of "ingot-iron" plate, ½x8 in. One-half the width of the strip is cast into the concrete of the abutting edge of a standard panel. This leaves 4 in. of metal projecting out from the surface of the end of the panel. The end of the slab, together with the projecting iron, is painted with a heavy coat of asphalt. The expansion panel is then cast so that its edge abuts against the edge of the slab of

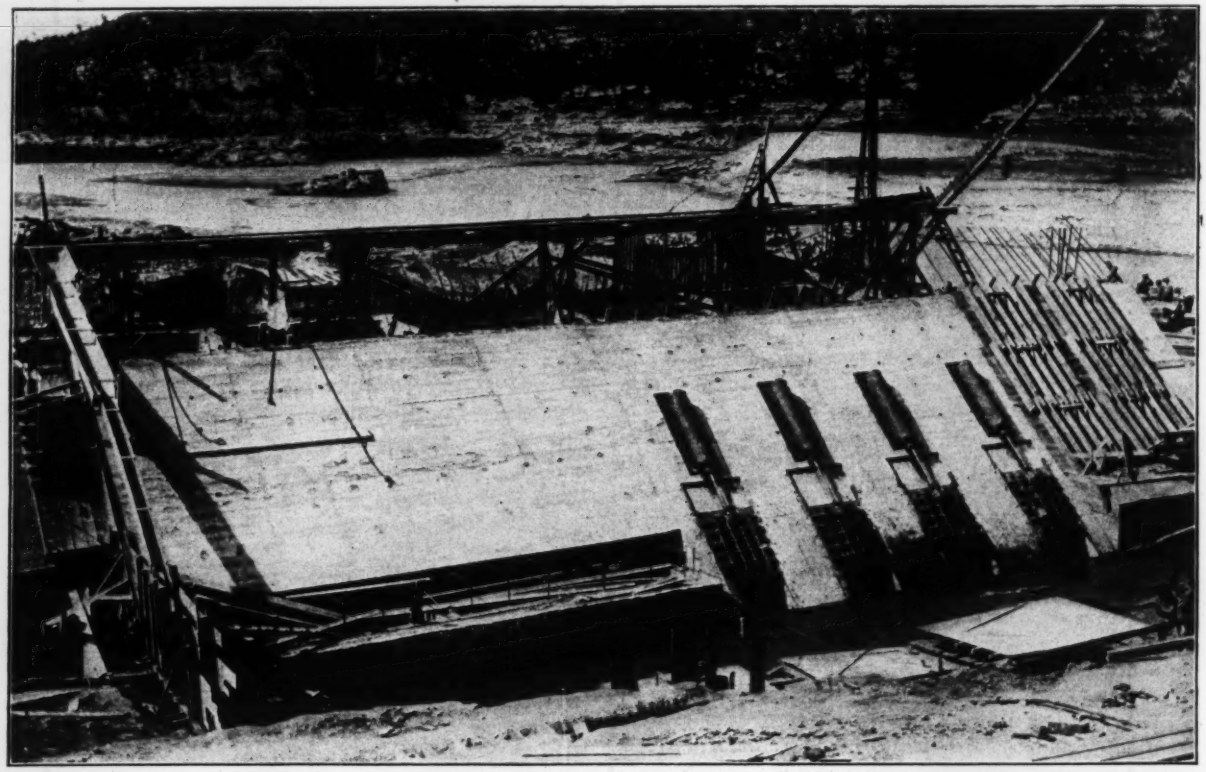


Fig. 5. Austin Dam under Construction, Showing Sluice Gates

the standard panel. Since its construction the dam has been subjected to temperatures varying from 32 to 90°, and these expansion joints have proved thoroughly satisfactory. Before construction was quite completed and when the whole of the dam was still exposed to the sun and atmospheric conditions, it was possible to see the space between the abutting ends of the panels at expansion joints change more than ¼ in. in a few hours.

Core Wall on East Side

Owing to the permeable condition of the limestone that forms the bluff on the east side of the river, a corewall joins the end of the bulkhead and passes eastward some 300 ft. forming practically a continuation of the dam into the rock. The bottom of the corewall is somewhat lower than that of the foundation of the dam, varying from 75 to 90 ft. Without this impermeable intercepting wall, there would be considerable leakage around the end of the dam, through the limestone that forms the eastern bluff.

Crest Gates

The crest gates, which are placed between the piers that project upward beyond the crest of the dam, on both the high and low sections, are made up of a structural-steel framework, of which the lower portion is filled with concrete while the upper part is covered with creosoted yellow pine. There are 28 large gates and 26 small ones, making a total of 1091 ft. of spillway. These gates turn about rockers, or bascules, which are fastened into the piers at either end of the gate. The large gates, which are placed on the low section of the dam, have, in addition, a middle bascule to support the middle and take the heavy water pressure. These large gates are continuous from pier to pier, and the middle bascule is placed on a low pier built entirely in the rear of the gate and projecting forward so that a portion of the rear surface of the gate rests against it.

When the gates are vertical and the water is at normal height, the center of pressure coincides in elevation with the point of support on the bascule curve. When the water rises above the normal level, the center of pressure likewise rises and there then exists a net moment to cause the gate to overturn. As overturning begins, the moment to cause it increases, owing to the increase in pressure on the upper portion of the gate and the diminution in pressure on the lower part. This increase in overturning moment is compensated for by the fact that the gate turning around the bascule is continuously changing its point of support, this point moving from a position at one-third the height of the gate to one very near the middle of it when it is in a horizontal position.

In order to prevent the gates from leaving the bascules and being pushed downstream, guide pins are placed at either end of the gate. These pins operate in curved channels of cast iron set into the concrete faces of the piers. In the large gates the water reaches an elevation of 65 ft. 9 in. before overturning takes place. When the gates are in horizontal position, after overturning, the depth of water from the crest to the under side of the gate is 5 ft. 4 in., while the depth of water from the upper surface to the surface of the water is 8 ft. 5 in., the thickness of the gate itself being 12 in.

The small gates, which are 6 ft. in height, overturn when the depth of water is 65 ft. 4 in., or when the water is 5 ft. 4 in. in depth over the crest. These small gates, therefore, overturn before the large ones do, and usually their operation gives more than ample discharge over the spillway to take care of normal river flow. Only in case of flood will the large gates open.

When the level of the water in the lake sinks sufficiently, these gates automatically close. This is effected by the counterweighting provided by the concrete filling in the bottom of the gates. The small gates close when the water has sunk 63 ft. 10 in., or when the level of the lake has dropped about 14 in. below normal. The large gates close at a water elevation of 64 ft. 8 in., or when the level of the lake has fallen to 4 in. below normal.

Sluice Gates

There are eight sluice gates, which are located as shown in Fig. 4. These are set in pairs, each discharging into its own opening and the two individual channels merging into one large tunnel, which passes through the dam. The gates are each 5x6 ft. and are operated by pistons working in cylinders, the working fluid being oil under a pressure of 750 lb. per sq.in. The cylinders are 12¾ in. inside diameter and the pistons have a 78-in. stroke. It will be observed that the direction of the water is changed on entering the throat of the sluice-gate passageway through a gradual curve until the direction of flow becomes horizontal, and also that the channels increase in area gradually so that practically no eddy currents are formed until after the two individual channels merge into the single large one, which passes through the bottom of the dam. Since this single channel is 18 ft. wide and approximately 14 ft. high, the total area is 250 sq.ft., while the area of the openings of the two sluice gates is only 30 sq.ft. each, or 60 sq.ft. for the two. The velocity of efflux through the sluice gates will be about 60 ft. per sec., while the velocity through the main channel will be less than 15 ft. per sec.

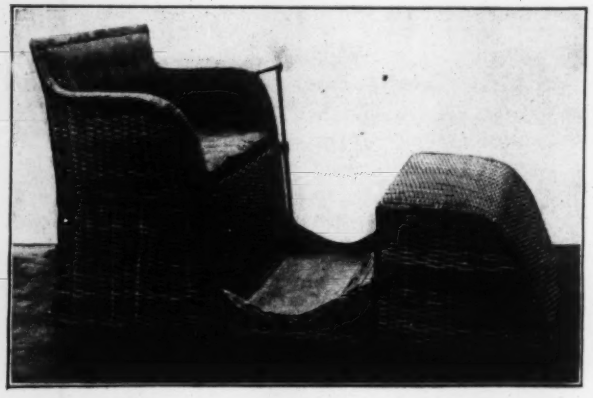
The oil-pressure cylinders which operate the gates are placed on the outside of the deck of the dam instead of inside the dam, as is the usual practice. In this way the cylinders could be placed much nearer to the sluice gates than is possible when the former are inside the dam and the latter outside. This shortens the piston rod, which, when the gate is being closed, acts as a long column, and for a given diameter of rod it is stiffer or for a given pressure a smaller rod may be used. This means that the size of the cylinder may be somewhat reduced. Furthermore, the saving in concrete and formwork effected by mounting these cylinders on the outside instead of the inside amounted to about $5000.

Personnel

The dam is being built under a franchise granted by the City of Austin to William B. Johnson, of Hartford, Conn., which franchise provided that the dam and power plant should be constructed by Johnson or his assigns and on completion turned over to the city, Johnson to receive $100,000 in cash on completion and acceptance, and $64,800 per annum in semiannual payments for 25 years, making a total payment of $1,720,000. Work was started under force account, but in June, 1912, a contract was entered into with William P. Carmichael Co., of St. Louis, to take over the work, and this company has carried it to completion. Lamar Lyndon was the engineer responsible for all plans and for the entire work; Frank S. Taylor was engineer in charge of construction.

An Electric Rolling Chair

The accompanying view shows an electric rolling chair recently put on the market and now in use at the San Diego and San Francisco expositions and on the boardwalks at various California seaside resorts. The surprising thing is that electricity has not before this been applied to the propulsion of rolling chairs. Where a rolling chair is pushed by a man, its rental cannot, of



ELECTRIC ROLLING CHAIR IN USE AT THE CALIFORNIA EXPOSITIONS

course, be less than the man's wage rate; and 50c. to $1 an hour is a common price for the use of rolling chairs. The amount of power required to propel a chair on smooth walks, however, is so little that a storage battery and electric motor of very moderate size are sufficient. Chairs can thus be rented at a price which greatly stimulates their use and yet yields an even larger profit to the owner than where a man must be hired to push the chair.

The chair illustrated is known as "The Osborn Electriquette" and is manufactured by the Electriquette Manufacturing Co., of Los Angeles, of which Clyde H. Osborn is president. It is carried on four rubber-tired wheels, the rear ones 14 in. diameter and the front ones, 8 in. The wheels have ball bearings packed with lubricating compound sufficient to last a year. A series-wound General Electric motor of ¼ hp. is used, transmitting its power through a double reduction gear using rawhide pinions to avoid noise, with a final drive by sprocket chain to the rear axle. The storage-battery equipment consists of two 6-volt units of 132-amp.-hr. capacity, the pair weighing about 140 lb. About 2 kw.-hr. of current will fully charge the batteries, and when so charged the chair can be run on level pavements an average of eight hours before the charge is exhausted. A hand lever across the lap of the driver is used for steering. The normal speed 3 mi. per hr., which is as high as is advisable for operation in crowded quarters, although the chair can be geared for higher speeds where desired. A brake drum on the rear wheel has a contracting brake-band which can be operated by either hand or foot, and in addition an emergency stop is provided. A plate extends across the floor within easy reach of the feet of both passengers. A slight push on this plate cuts off the current and applies the brake. That these safety appliances are effectual may be judged from the statement that, so far as is known, not one injury has resulted from the operation of these chairs.

The complete chair weighs about 525 lb. The seat is 38 in. wide and will accommodate two or three persons, although as an exhibition performance the chair has carried eight full-grown men. The electric controller used gives two forward speeds and one reverse.

The first chairs of this type were put into service at the San Diego Exposition at its opening. The introduction of the chair at the San Francisco Exposition followed shortly, and various ocean resorts in California then passed ordinances repealing the prohibition of self-propelled vehicles on their boardwalks.

300-Hp. Gasoline Motor Car for Fast Passenger Service

In ENGINEERING NEWS, Apr. 22, 1915, was illustrated and described a 300-hp. gasoline switching locomotive built by the McKeen Motor Car Co., of Omaha, Neb.,

A GASOLINE-ENGINE-DRIVEN TRAIN FOR LOCAL PASSENGER SERVICE, UNION PACIFIC R.R.

for use in Texas. This company has now applied an engine of this power to the driving of a gasoline motor car for the carriage of baggage, mail and express, the car having power enough to haul a standard steel passenger car.

A view of the new car is shown on p. 1094. The plan of placing the gasoline engine and machinery and the baggage, mail and express facilities on one car and using this to haul a passenger coach is the conception of Charles Ware, General Manager of the Union Pacific Ry. It is claimed that this equipment has capacity enough and power enough to displace a good share of the trains used in local branch passenger service. On its trial trip the car made a speed of 55 mi. per hr. This equipment is to be put into service between Kearney and Stapleton, Neb., displacing a steam passenger train. The distance is 103 mi., and the train will make the round trip of 206 mi. daily, giving a monthly average mileage of over 6000 mi. The seating capacity of the motor car train is 78 passengers. The motor car has a total weight on the driving wheels of 33,800 lb. and can exert a tractive effort of 8200 lb. The car is 70 ft. long, with a wheel base of 44 ft. 2 in. The post-office compartment is 15 ft. long, and the compartment for express and baggage is 38 ft. 3 in. The front truck of the car has a 10-ft. wheel base and the rear truck 7 ft.

News of the Engineering World

Riensh-Wurl Sewage Screens for Brooklyn

Two 6,000,000-gal. Riensch-Wurl sewage screens, each 14 ft. in diameter, are being installed at the 26th Ward sewage-treatment plant of the Borough of Brooklyn by the Sanitation Corporation, Morris Building, Philadelphia. A portion of the 18,000,000 to 20,000,000-gal. dry-weather flow of sewage will be passed through these screens and then on to tidewater without further treatment. The old and much overworked treatment works will receive the remainder of the dry-weather flow. It is expected that these screens will remain in use as a part of the new sewage-treatment works which are to be designed after the completion of the experiments at the existing works. (See ENGINEERING NEWS, Oct. 22, 1914.) E. J. Fort is Chief Engineer and Geo. T. Hammond is Designing Engineer of the Brooklyn Bureau of Sewers.

Massachusetts' Largest Appropriation for Highways

The legislature of Massachusetts has passed a bill, which has received the governor's approval, appropriating the sum of $2,500,000 for highway construction in the five western counties of Berkshire, Franklin, Hampden, Hampshire and Worcester. This is in addition to the regular road funds, which amount to about $1,500,000 per annum. Surveying parties are now at work in the western part of the state.

The Calumet-Sag Drainage Canal for Chicago

The Sag Canal is a drainage channel now under construction from the Calumet River (near Blue Island, Ill.) to the main drainage canal of the Sanitary District of Chicago. Its purpose is to deliver to the latter canal the foul water of the river which is now discharged into Lake Michigan, endangering the city's water-supply. The river flow is intended to be supplemented by water from the lake. The U. S. Government has a suit pending to prevent the diversion from Lake Michigan of more water than the 4167 cu.ft. per sec. now authorized, and in view of this the trustees of the Sanitary District called for a report from the Chief Engineer as to the uses to which the canal could be put if the decision in this case is adverse to the district.

In his report Mr. Wisner, the Chief Engineer, reviews the history of this auxiliary drainage canal and states that for several reasons it should be constructed even if the flow of water is restricted. The canal is designed for a flow capacity of 2000 cu.ft. per sec. and to serve a population of 600,000. The total cost is estimated at $8,200,000, while the intercepting sewers, pumping stations, etc., to bring the sewage to the canal, will cost about $3,800,000 more. The total value of contracts let up to the end of December, 1914, was not far from $5,412,000, while the actual expenditures amounted to nearly $3,200,000. Practically all the right-of-way has been secured.

The engineer points out that even if the flow from the lake should be restricted and sewage treatment therefore required, the effluent from the treating plant should be conducted to the main drainage canal and not discharged into the lake. The Sag Canal will serve for this purpose.

One plan would be to complete the canal ($8,954,500) and provide the intercepting sewer, pumping station and Blue Island sewer ($3,451,800) and supplement this with a treatment plant for a population of 300,000 (up to 900 gal. per capita), costing $3,673,000, making a total cost of about $16,100,000. An alternative would be to abandon the canal and build a covered sewer from Blue Island to the main channel (450 cu.ft. per sec). Allowing $3,173,000 for the amount already expended (without any further allowance for settling claims, etc.), $5,728,000 for the sewer, and $6,930,000 for the sewage treatment (including intercepting sewers, pumping station, etc.), the cost would be about $15,831,000, or within 1% of the cost of the present canal completed and supplemented with treatment works.

The advantages of the open canal over a closed conduit, or sewer, are as follows: (1) Its better effectiveness in handling not only the dry-weather flow, but also the storm-water flow from the Calumet district; (2) its value as a

barge canal; (3) its value for drainage of property (thus creating land values); (4) if the Sanitary District should be allowed to take from the lake the desired flow of 10,000 cu.ft. per sec., the canal project will be much the cheaper and will care for twice the population provided for by the other projects. Mr. Wisner considers, therefore, that the present Calumet-Sag Canal should be proceeded with, and pushed to completion as soon as possible.

An Engineering Competition

The congestion of traffic at the intersection of Fifth Ave. in New York City and heavily traveled cross streets has led the Municipal Art Society, 119 East 19 St., New York City, to hold a competition, with prizes of $300, $200, and $100 for the best ideas submitted for the solution of the problem.

In the problem the avenue was assumed to run north and south, the street east and west. Each was 100 ft. between building lines. The blocks on the avenue were 200 ft. 10 in. long; those on the street were 920 ft. on the west side of the avenue and 420 ft. on the east side. The avenue carried twice the traffic of the street. There were no surface cars on the avenue, but there were two tracks on the street. The plan drawings submitted were to be of scale 1 in. = 32 ft.; for cross-sections and elevations, 1 in. = 16 ft. Drawings were limited in number to four. The competition closed May 22, two months having been allowed. The high value of real estate at this intersection was impressed upon the competitors, who were urged in the interests of public economy to relieve the congestion, if possible, by increasing the utility of the real estate in the vicinity.

From more than 200 competitors John Floyd Yewell, Peekskill, N. Y., was picked to receive the first prize. His plan provided for a tower in the center of the intersection, with the angles of the buildings on the four corners cut off, so as to allow rotary circulation. The car tracks on the cross streets were depressed so as to pass under the avenue, as did also vehicular traffic. The plan involved a comparatively small amount of property condemnation. The second prize was awarded to John Ambrose Thompson and Ernest F. Lewis, 101 Park Ave., whose solution was considered the most effective from a purely architectural point of view. Galvin Kiessling and Herbert E. Davis, 175 Fifth Ave., received the third prize. Honorable mention was accorded five others.

More Money for Barge Canal

A bill has been introduced in the New York State Assembly "making provision for issuing bonds to an amount not to exceed $27,000,000" for the continuation of the New York State Barge Canal. This bond issue will bring the total of the bonds issued to build the Canal up to $154,500,000.

ENGINEERING SCHOOLS

TUFTS COLLEGE—The exercises for the inauguration of H. C. Bumpus as president will be held at Medford, Mass., on Saturday, June 12. The installation addresses will be given in the morning. In the afternoon there will be a discussion on "Obligations of the College to the State" by Gov. D. I. Walsh of Massachusetts, Dean L. E. Reber of the University of Wisconsin, President K. L. Butterfield of the Massachusetts Agricultural College, President Alexander Meiklejohn of Amherst College, President G. Stanley Hall of Clark University, Sarah L. Arnold, of the Massachusetts Board of Education, and Principal W. C. Hill of the Springfield Central High School.

NEWS NOTES

Mount Lassen Again in Eruption—Mount Lassen, our volcano in the Lassen National Forest in California, was again active on May 24. Fires started which destroyed considerable timber, but fortunately most of the fires were extinguished by the heavy rains which followed the eruption.

A Tornado in Arcola, Ind., 9 mi. west of Fort Wayne, on May 21 picked up a new grain elevator belonging to the Farmers' Equity Exchange and deposited the mass of wreckage on the Pennsylvania R.R. tracks near by. The path of the tornado was apparently ½ mi. wide, the storm moving westward.

A Traction Engine Went Through a New Bridge over a canal at Knights Landing in Yolo County, California, on May 17, dropping 15 ft. into the canal below. Press dispatches state that the bridge had recently been completed at an estimated cost of $50,000. It had been damaged to some extent by recent high water.

Standardization of Grades and compensation in the civil engineering service of the State of Massachusetts is to be investigated under an act of legislature of May 26, 1915, and reported on by January, 1916, with a view to preparing a classified service with appointments and promotion under civil-service regulations.

Additional Water-Supply for San Diego—The purchase of the property of the Volcan Land & Water Co. for an additional domestic water-supply for San Diego, Calif., has been recommended in a report by M. M. O'Shaughnessy, of San Francisco, and J. B. Lippincott, of Los Angeles, Consulting Engineers to San Diego. The value of the property in its present undeveloped condition is placed at $2,500,000. The report includes estimates for the cost of building dams, conduits and other appurtenances.

River-Regulating Districts may be formed in New York State under the provisions of the so-called Machold water-storage bill, signed by Governor Whitman on May 22. Under this act any watershed of the state or any integral part of any such watershed may be converted into a river-regulating district by the Conservation Commission upon petition properly prepared and not opposed in public hearing. The district so created has then the power to prepare plans, issue bonds and carry out work for the purpose of controlling the water powers in the district.

Local Assessments for Mosquito Extermination in portions of New York City are authorized by an act of the New York legislature which is to take effect immediately. The act, which is an amendment to the city charter, is as follows:

> The cost and expense of the construction of drains upon or of other improvements to low or wet lands in the boroughs of Brooklyn and Queens, for the elimination of mosquitoes, by the board of health, shall be borne by the property benefited within an area of benefit to be fixed by the board of assessors, or such portion of the amount of such cost and expense as the board of health may determine and certify to the board of assessors. Assessments therefor shall be made by such board of assessors as provided in chapter seventeen of this act.

The Ohio River Bridge at Metropolis, Ill., is not to be built at this time, and work on the bridge and its approaches has been postponed indefinitely. The Paducah & Illinois R.R. (of which the bridge is to be an important feature) will be built, however, to form a connection in a new route between Chicago and Gulf ports. On each side of the river the line will be laid down the bank to a car incline and landing for a car ferry. The line will be 15 mi. in length, connecting the Chicago, Burlington & Quincy R.R., at Metropolis, Ill., with the Nashville, Chattanooga & St. Louis R.R. at Paducah, Ky. C. H. Cartlidge, Chief Engineer, is Bridge Engineer of the former road, and construction work is being done under the direction of that road. The proposed Ohio River bridge was described in "Engineering News, July 30, 1914.

Heavy Rains in Kansas City, Mo., during May damaged bridges, culverts, park property and streets to the extent of about $100,000, according to local estimate. The precipitation

in this month was 10.87 in. The Kaw River reached on May 28 a stage of 22.3—only 2.7 ft. below flood stage. The Missouri at its junction with the Kaw was at the same level, and considerable uneasiness was felt by the inhabitants of Armourdale and lower Kansas City, Kan. Several miles of track was washed out on the Missouri Pacific Ry. and the Chicago, Burlington & Quincy R.R. in the vicinity of Kansas City. On May 29 both rivers were falling. In Nebraska the Nemaha and the Muddy Rivers were out of banks and caused considerable loss to farmlands. In Lincoln a heavy rain occurred in the latter part of May, when for 35 min. the rain fell at the rate of 5 in. per hr. In Auburn 3½ in. fell in 7 hr. on May 25.

The Engineering Foundation held its first regular meeting on May 25. Rules of administration were adopted and the following officers elected: Chairman, Gano Dunn; vice-chairman, Edward D. Adams; secretary, F. R. Hutton; treasurer, Joseph Struthers. The Foundation was organized by the United States Engineering Society, representing jointly the Electrical, Mining and Mechanical Engineers, with the coöperation of the Civil Engineers, combining about 30,000 members. It was made possible through the generosity of Ambrose Swasey, of Cleveland, Ohio, who made the initial gift of a quarter of a million dollars to be devoted to the benefit of mankind through fostering engineering research. The board administering this trust consists of Edward D. Adams, Gano Dunn, Howard Elliott, Dr. Alex. C. Humphreys, Charles Warren Hunt, Dr. A. R. Ledoux, Dr. M. I. Pupin, Chas. E. Scribner, J. Waldo Smith, Jesse M. Smith and Benj. B. Thayer. Applications for the use of funds were received in large numbers and a committee, consisting of Dr. A. R. Ledoux, J. Waldo Smith, Dr. M. I. Pupin, and Dr. Alex. C. Humphreys, was appointed to consider them. Most of the applications were in such form that they could not be passed upon, and the committee is preparing a schedule of requirements with which applicants must comply.

PERSONALS

Mr. Leon Briggs, of Joplin, Mo., has been appointed City Engineer of Webb City, Mo., succeeding Mr. Frank A. Martin.

Mr. James Nisbet Hazlehurst, M. Am. Soc. C. E., who has been in ill health for some time due to a nervous breakdown from overwork, expects to resume his practice of consulting municipal engineering in Atlanta this fall.

Mr. Frederick E. Everett has been appointed Acting State Highway Commissioner of the newly established Highway Department of New Hampshire, to succeed the late S. Percy Hooker, State Superintendent of Highways, who died last winter.

Mr. Harry D. Appleby has resigned as Chief Engineer of the Bureau of Design and Survey of the Borough of Manhattan, New York City. The bureau has been abolished and the work divided among the bureaus of highways, sewers and topography.

Mr. Merton A. Pocock, Assoc. Am. Inst. E. E., has been appointed District Sales Manager of the Terry Steam Turbine Co., of Hartford, Conn., for the states of Minnesota, North Dakota and South Dakota. His office is 400 Endicott Building, St. Paul, Minn.

Mr. C. H. Morse has retired from the presidency of Fairbanks, Morse & Co., Chicago, Ill., after 24 years of service in that capacity. His son, C. H. Morse, Jr., M. Am. Soc. M. E., president of the Fairbanks-Morse Manufacturing Co., Beloit, Wis., has been elected president, the other officers of the company being reëlected.

Mr. George H. Hazlehurst, consulting municipal engineer, until recently associated with his father, James Nesbit Hazlehurst, M. Am. Soc. C. E., of Atlanta, Ga., in the practice of consulting municipal engineering, sailed on May 15 for Servia, where he will join the sanitary engineering service of the American Red Cross, which is working to stamp out typhus fever there.

OBITUARY

James H. Cochran, of the firm of Cochran & Davis, of Pittsburgh, Penn., died at his home in that city on May 24 at the age of 72. Mr. Cochran had been in the contracting and building business in Pittsburgh for 40 years.

Robert Nesch, president of the Pittsburg (Kan.) Paving Brick Co., died at his home in Kansas City, Mo., on May 19. In 1890 Mr. Nesch joined the organization of the brick company and since 1900 had general charge of the company's offices in Kansas City. He was born in Switzerland in 1852.

Joseph Dixon, a pioneer in the underground transit development of New York City half a century ago, died recently in London, where he resided for about 20 years. Mr. Dixon, with the late Alfred E. Beach, organized the Beach Pneumatic Co., which afterward became the Broadway Underground Co., of which Mr. Dixon was Superintendent, and which, more than 40 years ago, built the 200 ft. of underground railway at Broadway and Warren St., New York City. He is survived by his widow, two sons and a daughter.

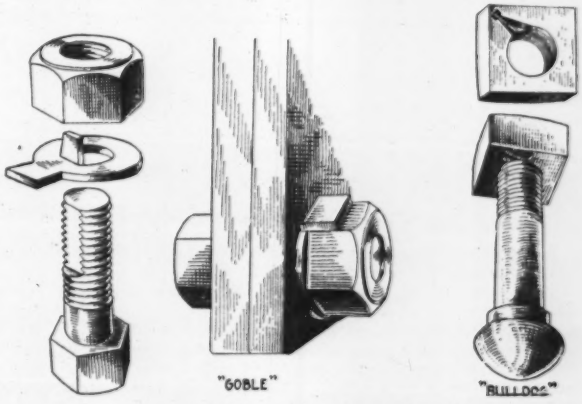
Louis T. Hickey, Assoc. M. Am. Soc. C. E., a civil and hydraulic engineer widely known on the Pacific Coast, died of pneumonia at his home in Berkeley, Calif., on May 18. Mr. Hickey was a graduate of the University of California with the class of 1906. After graduation he was employed on the location of the Northwestern Pacific R.R., from which position he resigned to engage in private practice in Tacoma. He reported on several important hydro-electric projects in the northwest and, in coöperation with Cyril Williams, Jr., M. Am. Soc. C. E., made an exhaustive study of the underground water-supply of Livermore Valley, California. He was also identified with the recent appraisal of the $34,000,000 properties of the Spring Valley Water Co. He is survived by a widow and a brother, J. P. Hickey, C. E., who was associated with him in much of his engineering work.

James Blaine Miller, Assoc. M. Am. Soc. C. E., Assistant of the United States Coast and Geodetic Survey, is believed to have perished with the sinking of the "Lusitania," as his name is not in the list of survivors and nothing has been heard from him since that time. Mr. Miller was in the service of the Survey for 12 years. Upon graduation from Oberlin College, in 1903, he was appointed Aid to the Survey and promoted to Assistant in 1906. During his service he was employed chiefly on hydrographic and leveling work in various localities. In March of the present year he was detached from the steamer "Patterson," of which he had been in command for surveying work in the Hawiian Islands and on the coast of Alaska, and had been granted a leave of absence for a vacation abroad. He is survived by his father, Thomas C. Miller, attorney-at-law, of Erie, Penn.

Appliances and Materials

Two New Nut Locks

Two new nut locks are shown in the accompanying sketch. The "Goble" design of the Positive Nut-Lock & Tie Co., of Grand Rapids, Mich., is a combination nut lock and washer. A flatted bolt is put in place, the washer slipped on and followed with the nut, which cuts its own thread on the soft, wedge-shaped washer tongue. Thus lost motion between the



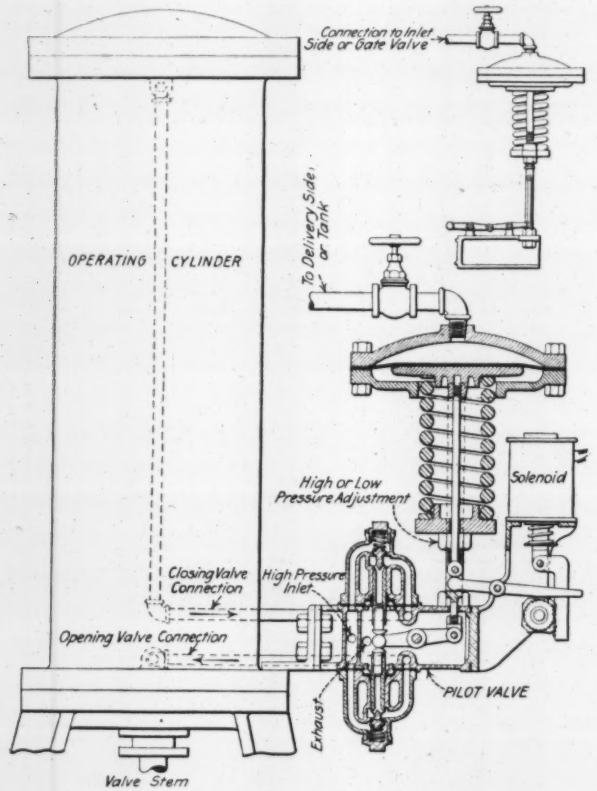
TWO NEW NUT LOCKS

nut and bolt is taken up; bending down the washer lip, when the nut is screwed home, locks the latter from turning back.

The "Bulldog" design of the Daniels Safety Device Co., So. La Salle St., Chicago, has a pawl in a recess of the nut. The action is obvious.

Automatic Gate-Valve Control

An automatic control for hydraulic gate valves, as devised by the Golden-Anderson Valve Specialty Co., of Pittsburgh, is shown in the accompanying sketch. The gate is open due to low pressure on the delivery or tank side, insufficient to push the control diaphragm and spindle down against the coiled spring. The pilot-valve arm has closed the lower exhaust from the operating cylinder, opened the upper exhaust, closed the upper and opened the lower pressure inlet. When the pressure above the diaphragm rises to some predetermined value the pilot valve positions will be shifted and the operating cylinder made to shut the gate. By adding a solenoid attachment the valve position can be put under distant control. By using a second diaphragm with reversing lever in place of the solenoid, and adjusting it to a few pounds above normal, the pilot can be thrown by increased pressure on the supply main. By connecting the diaphragm pressure chamber (single-



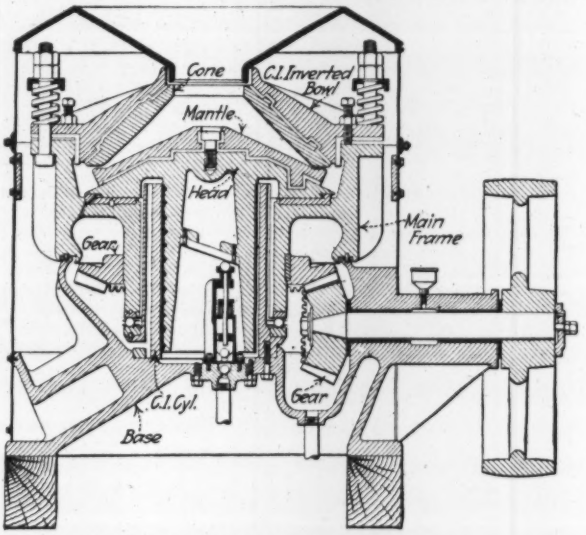
AUTOMATIC HYDRAULIC GATE-VALVE CONTROL

diaphragm type) also to the high-pressure inlet side through a check valve the pilot can be made to close the gate at a predetermined tank pressure and yet to open it for return flow when the pressure becomes less on the inlet side.

* * *

New Secondary Rock Crusher

A new crusher, called the "Telsmith Intercone Mill," has been developed by the Smith Engineering Works, of Milwaukee, for reducing 3-in. stone to ½- or ¼-in. size. The construction of the mill is shown by the accompanying section. There is a cast-iron stationary base, a cast-iron cylinder, which is bored eccentric and attached rigidly to the base, a main frame rotated about the eccentric by gears, an umbrella-shaped head inside of and supported by the outer frame, rotating by friction only. The head and frame both revolve at 150 r.p.m., but on different centers. They are supported on a ball bearing. The stone is crushed between a manganese-steel mantle (on the inverted bowl carried by the outer frame) and a manganese-steel cone (on the head). Since the head and frame rotate on different centers, the stone is pinched where the two crushing members approach. The stone works down between the converging surfaces and finally emerges between the mantle and cone, passing out between the arms of the outer frame into a discharge chute. There is a plunger oil pump inside the umbrella head. The flow is up through a channel on the inner-babbitted bearing, over the top of the eccentric spindle and into a channel coming down on the outside of the eccentric. Part of the oil is thrown outward between the head and main rotating frame to oil this large bearing. An overflow channel on the thicker side of the eccentric bypasses any surplus oil into the gear casing. The main stream goes out through the ball bearing,



SMITH INTERMEDIATE CRUSHER

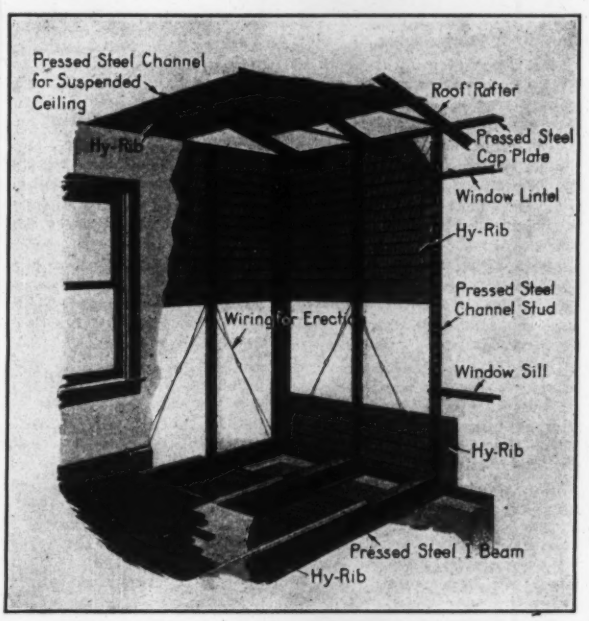
and the whole supply is finally drained from the base, cooled, cleaned and returned to the pump.

The output for ¼-in. stone and under is about two tons per hour. For ½-in. stone and under the capacity is about five tons per hour. The horsepower required is 15 to 20 and 10 to 15 respectively. The mill weighs 8600 lb.

* * *

Pressed-Steel Building Construction

A new type of building construction, with a main frame of interlocking pressed-steel beams and studs, is being put on the market by the Trussed Concrete Steel Co., Youngstown, Ohio. The accompanying view shows a skeleton corner of a typical building erected according to the new system. The



PRESSED STEEL BUILDING CONSTRUCTION

beams and studs are of pressed-steel channel and I-beam sections, with keyhole slots in which to fit, with the assistance of wedges, the joining sills, rafters, etc., and protruding prongs which can be clinched down over the "hy-rib" expanded metal that forms the backing for interior plaster and exterior stucco. The erection work thus requires hardly any other tool than a hammer. The system is recommended by the manufacturers for small fireproof houses, garages, etc.

Engineering Societies of the United States and Canada

The following list of the engineering societies of the United States and Canada has been selected from the more extended card index of such societies kept in the office of ENGINEERING NEWS. The data have recently been brought up to date, but the delays incident to a correspondence with over 400 societies have probably already caused some errors of commission in the printed record of officers and number of members, although it is thought that the names of the secretaries and their office address are correct to date. Any omissions of societies entitled to a place in the list or the correction of any errors in the record should be sent into this office soon so that the list may be made as correct as possible in the reprint which it is intended to make.

The societies have been divided into 146 national, 102 state and district and 48 local, a more or less arbitrary classification but one which has been found useful in this office. The information sought—and generally received—has been the name and office address, the name of the secretary and president, the number of members and the usual month of the annual meeting.

NATIONAL SOCIETIES

Air Brake Association—Secy., F. M. Nellis, 53 State St., Boston, Mass. Annual meeting in May. Number of members: 1200.

Aëro Club of America—Secy., Howard Huntington, 297 Madison Ave., New York City. Pres., Alan R. Hawley. Annual meeting in November. Number of members: 550.

Aëronautical Society of America—Secy., Edward Durant, 29 West 39th St., New York City. Pres., T. R. MacMechan. Annual meeting in February. Number of members: 200.

American Association for the Advancement of Science—Secy., L. O. Howard, Smithsonian Institution, Washington, D. C. Pres., Dr. William Wallace Campbell. Annual meeting in December. Number of members: 8000.

American Association of Port Authorities—Secy., William J. Barney, Room 1200, 29 Broadway, New York City. Pres., O. F. Lackey. Annual meeting in October. Number of members: 101.

American Association of Railroad Superintendents—Secy., E. H. Harman, Room 101, Union Station, St. Louis, Mo. Pres., Charles Burlingame. Annual meeting in August. Number of members: 400.

American Association of Refrigeration—Secy., J. F. Nickerson, 431 South Dearborn St., Chicago, Ill. Pres., Frank A. Horne.

American Automobile Association—Secy., J. N. Brooks, Riggs Bldg., Washington, D. C. Annual meeting in May. Number of members: 100,000 (including 551 clubs).

American Boiler Manufacturers' Association—Secy., J. D. Farasey, 37th St., Cleveland, Ohio.

American Ceramic Society—Secy., Prof. Edward Orton, Jr., Columbus, Ohio. Pres., Prof. C. W. Parmelee. Annual meeting in February. Number of members: 600.

American Chemical Society—Secy., Charles L. Parsons, Box 505, Washington, D. C. Pres., Dr. Charles H. Herty. Annual meeting in April. Number of members: 7200.

American Civic Association—Secy., Richard B. Watrous, 914 Union Trust Bldg., Washington, D. C. Pres., J. Horace McFarland, Harrisburg, Penn. Annual meeting in December. Number of members: 2500.

American Concrete Institute (formerly Nat. Assn. of Cement Users)—Secy., C. L. Fish, 1418 Walnut St., Philadelphia, Penn. Pres., Leonard C. Wason. Annual meeting in February. Number of members: 900.

American Economic Association—Secy., Allyn A. Young, Cornell University, Ithaca, N. Y. Pres., Prof. Walter F. Willcox. Annual meeting in December.

American Electric Railway Association—Secy., E. B. Burritt, 29 West 39th St., New York City. Pres., C. Loomis Allen. Annual meeting in October. Number of members: 400 companies; 3200 individuals.

American Electric Railway Manufacturers' Association—Secy., H. G. McConnaughy, 165 Broadway, New York City. Pres., Edwin H. Baker. Annual meeting in October. Number of members: 324.

American Electrochemical Society—Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn. Pres., Lawrence Addicks. Semiannual meeetings in April and September. Number of members: 1350.

American Forestry Association—Secy., P. S. Ridsdale, 1410 H St., N. W., Washington, D. C. Pres., Dr. Henry S. Drinker. Annual meeting in January. Number of members: 8500.

American Foundrymen's Association—Secy., A. O. Backert, Penton Bldg., Cleveland, Ohio. Pres., R. A. Bull. Annual meeting in September. Number of members: 851.

American Gas Institute—Secy., George G. Ramsdell, 29 West 39th St., New York City. Pres., Edward C. Jones. Annual meeting in October. Number of members: 1600.

American Hardware Manufacturers' Association—Secy., F. D. Mitchell, 1510 Woolworth Bldg., New York City. Pres., William H. Matthai. Annual meeting in October. Number of members: 350.

American Highway Association—Secy., I. S. Pennybacker, 708 Colorado Bldg., Washington, D. C. Pres., Fairfax Harrison. Number of members: 1700.

American Institute of Architects—Secy., Burt L. Fenner, 101 Park Ave., New York City. Pres., R. Clipston Sturgis. Annual meeting in December. Number of members: 1087.

American Institute of Chemical Engineers—Secy., J. C. Olsen, Cooper Union, New York City. Pres., George D. Rosengarten. Annual meeting in December. Number of members: 218.

American Institute of Consulting Engineers—Secy., F. A. Molitor, 35 Nassau St., New York City. Pres., Elmer L. Corthell. Annual meeting in January. Number of members: 81.

American Institute of Electrical Engineers—Secy., F. L. Hutchinson, 33 West 39th St., New York City. Pres., Paul M. Lincoln. Annual meeting in June. Number of members: 7747.

American Institute of Metals—Secy., William M. Corse, 106 Morris Ave., Buffalo, N. Y. Pres., G. H. Clamer. Annual meeting in September. Number of members: 301.

American Institute of Mining Engineers—Secy., Bradley Stoughton, 29 West 39th St., New York City. Pres., William L. Saunders. Annual meeting in February. Number of members: 5000.

American Iron and Steel Institute—Secy., James T. McCleary, Room 920, 30 Church St., New York City. Pres., Elbert H. Gary. Annual meeting in May. Number of members: 1351.

American Manufacturers' Export Association—Secy., E. V. Douglass, 66 Broadway, New York City. Pres., Alba B. Johnson. Annual meeting in October. Number of members: 300.

American Mathematical Society—Secy., F. N. Cole, 501 West 116th St., New York City. Pres., Ernest William Brown. Number of members: 700.

American Mine Safety Association—Secy., H. M. Wilson, 40th and Butler St., Pittsburgh, Penn. Pres., Dr. August F. Knoefel. Annual meeting in September. Number of members: 650.

American Mining Congress—Secy., J. F. Callbreath, Jr., 526 Munsey Bldg., Washington, D. C. Pres., Carl Scholz.

American Museum of Safety—Director, W. H. Tolman, 29 West 39th St., New York City. Pres., Arthur Williams. Annual meeting in February. Number of members: 400 (including company members).

American Peat Society—Secy., Julius Bordollo, Kingsbridge, New York City. Pres., Carl Kleinstuck. Annual meeting in September. Number of members: 143.

American Public Health Association—Secy., Prof. Selskar M. Gunn, 755 Boylston St., Boston, Mass. Pres., Prof. William T. Sedgwick. Annual meeting in September. Number of members: 1400.

American Railway Association—Secy., W. F. Allen, 75 Church St., New York City. Pres., H. U. Mudge. Semiannual meetings in May and November. Number of members (railway companies): 603.

American Railway Bridge and Building Association—Secy., C. A. Lichty, 215 Jackson Blvd., Chicago, Ill. Pres., L. D. Hadwen. Annual meeting in October. Number of members: 600.

American Railway Engineering Association—Secy., E. H. Fritch, 900 South Michigan Ave., Chicago, Ill. Pres., Robert Trimbles. Annual meeting in March. Number of members: 1200.

American Railway Master Mechanics' Association—Secy., Jos. W. Taylor, 1112 Karpen Bldg., Chicago, Ill. Pres., F. F. Gaines. Annual meeting in June. Number of members: 1100.

American Reclamation Federation—Pres., Edmund Perkins, First National Bank Bldg., Chicago, Ill.

American Road Builders' Association—Secy., E. L. Powers, 150 Nassau St., New York City. Pres., George W. Tillson. Annual meeting in February.

American Society of Agricultural Engineers—Secy., F. M. White, Agricultural Engineering Bldg., Madison, Wis. Pres., H. H. Musselman. Annual meeting in December. Number of members: 127.

American Society of Civil Engineers— Secy., Charles Warren Hunt, 220 West 57th St., New York City. Pres., Charles D. Marx. Annual meeting in January. Number of members: 7708.

American Society of Engineering Contractors—Secy., J. R. Wemlinger, 29 West 39th St., New York City. Pres., Hillis F. Hackedorn. Annual meeting in January. Number of members: 603.

American Society of Engineers, Architects and Constructors—Secy., T. Hugh Boorman, 35 West 39th St., New York City. Pres., Maj. Samuel P. Hatfield. Annual meeting in January. Number of members: 250.

American Society of Heating and Ventilating Engineers—Secy., J. J. Blackmore, 29 West 39th St., New York City Pres., D. D. Kimball. Annual meeting in January. Number of members: 510.

American Society of Hungarian Engineers and Architects—Secy., Edmund Szekely, 450-458 19th St., Brooklyn, N. Y. Annual meeting in January. Number of members: 68.

American Society of Mechanical Engineers—Secy., Calvin W. Rice, 29 West 39th St., New York City. Pres., Dr. John A. Brashear. Annual meeting in December. Number of members: 6100.

American Society of Municipal Improvements—Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind. Pres., William A. Howell. Annual meeting in October. Number of members: 500.

American Society of Naval Engineers—Secy., Lieut. A. T. Church, U. S. N., Navy Dept., Washington, D. C. Pres., Capt. S. S. Robison. Annual meeting in October. Number of members: 861.

American Society of Refrigerating Engineers—Secy., William H. Ross, 154 Nassau St., New York City. Pres., Louis K. Doelling. Annual meeting in December. Number of members: 350.

American Society of Swedish Engineers—Secy., E. V. Carlson, 271 Hicks St., New York City. Pres., Albin Gustafson. Annual meeting in January. Number of members: 325.

American Society for Testing Materials—Secy., Prof. Edgar Marburg, University of Pennsylvania, Philadelphia, Penn. Pres., A. W. Gibbs. Annual meeting in June. Number of members: 1758.

American Supply and Machinery Manufacturers' Association—Secy., F. D. Mitchell, 1510 Woolworth Bldg., New York City. Pres., Farnham Yardley. Annual meeting in June.

American Water Works Association—Secy., J. M. Diven, 47 State St., Troy, N. Y. Pres., George G. Earl. Annual meeting in May. Number of members: 1190.

American Wood Preservers' Association—Secy., F. J. Angier, Mount Royal Station, Baltimore, Md. Pres., J. H. Waterman. Annual meeting in January. Number of members: 300.

Association of American Portland Cement Manufacturers—Secy., Percy H. Wilson, 1418 Walnut St., Philadelphia, Penn. Pres., John B. Lober. Annual meeting in December. Number of members: 70 companies.

Association of American Steel Manufacturers—Secy., Frank A. Robbins, Jr., care the Pennsylvania Steel Co., Steelton, Penn. Pres., P. E. Carhart. Annual meeting in March. Number of members: 34 companies.

Association of Edison Illuminating Companies—Secy., George C. Holberton, Pacific Gas & Electric Co., San Francisco, Calif. Pres., Walter F. Wells. Annual meeting in September. Number of members: 73.

Association of Engineering Societies—Secy., Joseph W. Peters, 3817 Olive St., St. Louis, Mo. Chairman, John W. Woermann. Number of members: 800.

Association of Iron and Steel Electrical Engineers—Secy., W. T. Snyder, care National Tube Co., McKeesport, Penn. Pres., O. R. Jones. Annual meeting in September. Number of members: 310.

Association of Railway Electrical Engineers—Secy., Joseph A. Andreucetti, C. & N. W. Ry., Chicago, Ill. Pres., H. C. Meloy. Annual meeting in October. Number of members: 600.

Association of Railway Telegraph Superintendents—Secy., P. W. Drew, 112 West Adams St., Chicago, Ill. Pres., W. C. Walstrum. Annual meeting in June. Number of members: 200.

Canadian Cement and Concrete Association—Secy., W. Snaith, 57 Adelaide St., East Toronto, Ont. Pres., Peter Gillespie.

Canadian Electrical Association—Secy., Alan Sullivan, 12 Adelaide St., East, Toronto, Ont. Pres., D. R. Street. Annual meeting in June.

Canadian Electric Railway Association—Secy., Acton Burrows, 70 Bond St., Toronto, Ont. Pres., C. B. King.

Canadian Mining Institute—Secy., H. Mortimer Lamb, 911, Ritz-Carlton Hotel, Montreal, Que. Pres., G. G. S. Lindsey. Annual meeting in March. Number of members: 1027.

Canadian Railway Club—Secy., James Powell, P. O. Box 7, St. Lambert, Que. Pres., W. McNab. Annual meeting in May. Number of members: 775.

Canadian Society of Civil Engineers—Secy., C. H. McLeod, 176 Mansfield St., Montreal, Que. Pres., Francis Clarke Gamble. Annual meeting in January.

Canadian Society of Forest Engineers—Secy., Ellwood Wilson, Grand Mere, Que. Pres., Prof. B. E. Fernow. Annual meeting in January. Number of members: 72.

Compressed Gas Manufacturers' Association—Secy., John J. O'Rorke, 25 Madison Ave., New York City. Pres., Dr. Hugo Lieber. Annual meeting in January. Number of members: 100.

Electrical Manufacturers' Club—Secy., A. D. Page, Room 937, 30 Church St., New York City. Pres., Walter Cary. Annual meeting in November. Number of members: 88.

Electric Vehicle Association of America—Secy., A. Jackson Marshall, 29 West 39th St., New York City. Pres., John F. Gilchrist. Annual meeting in October. Number of members: 980.

Engineering Association of the South—Secy., W. Harwell Allen, 930 Stahlman Bldg., Nashville, Tenn. Pres., Charles S. Brown. Annual meeting in December. Number of members: 200.

General Contractors' Association—Secy., C. A. Crane, 51 Chambers St., New York City. Pres., Thomas Crimmins. Annual meeting in December. Number of members: 125.

Geological Society of America—Secy., E. O. Hovey, American Museum of Natural History, New York City. Pres., A. P. Coleman.

Illuminating Engineering Society—Secy., C. A. Littlefield, 29 West 39th St., New York City. Pres., Dr. A. S. McAllister. Annual meeting in September. Number of members: 1500.

Institute of Radio Engineers—Secy., David Sarnoff, 233 Broadway, New York City. Pres., John Stone. Annual meeting in January. Number of members: 700.

International Acetylene Association—Secy., A. Cressy Morrison, 42nd St. Bldg., New York City. Pres., J. M. Morehead. Annual meeting in July. Number of members: 125.

International Association of Fire Engineers—Secy., James McFall, Roanoke, Va. Pres., Hugo R. Delfs. Annual meeting in September.

International Association of Municipal Electricians—Secy., Clarence R. George, Houston, Tex. Pres., W. H. Flandreau. Annual meeting in September. Number of members: 250.

International Association for the Prevention of Smoke—Secy., S. H. Viall, Chicago, Ill. Pres., L. A. Tower. Annual meeting in September.

International Irrigation Congress—Secy., Arthur Hooker, Spokane, Wash. Pres., J. B. Case. Annual meeting in September. Members selected by appointment.

International Railroad Master Blacksmiths' Association—Secy., A. L. Woodworth, 752 West North St., Lima, Ohio. Pres., T. F. Buckley. Annual meeting in August. Number of members: 300.

International Railway Fuel Association—Secy., C. G. Hall, 922 McCormack Bldg., Chicago, Ill. Pres., D. R. MacBain. Annual meeting in May. Number of members: 662.

International Railway General Foremen's Association—Secy., William Hall, 1126 West Broadway, Winona, Minn. Pres., W. W. Scott. Annual meeting in July. Number of members: 220.

Inventors' Guild—Secy., Thomas Robins, 13 Park Row, New York City. Pres., Dr. L. H. Baekeland. Annual meeting in March. Number of members: 28.

Inventors' League of the United States—Secy., Ralph J. Lackner, 154 Malden Lane, New York City. Pres., E. A. Munns. Number of members: 150.

League of American Municipalities—Secy., Robert E. Lee, City Hall, Baltimore, Md.

Master Boiler Makers' Association—Secy., Harry D. Vought, 95 Liberty St., New York City. Pres., J. T. Johnston. Annual meeting in May. Number of members: 450.

Master Car and Locomotive Painters' Association—Secy., A. P. Dane, 16 Mineral St., Reading, Mass. Pres., Thomas J. Hutchinson. Annual meeting in September. Number of members: 300.

Master Car Builders' Association—Secy., Joseph W. Taylor, 1112 Karpen Bldg., Chicago, Ill. Pres., D. F. Crawford. Annual meeting in June. Number of members: 1000.

Mining and Metallurgical Society of America—Secy., F. F. Sharpless, 52 Broadway, New York City. Pres., W. R. Ingalls. Annual meeting in January. Number of members: 263.

National Association of Cotton Manufacturers—Secy., C. J. H. Woodbury, 45 Milk St., Boston, Mass. Pres., Albert Greene Duncan. Annual meeting in April. Number of members: 915.

National Association of Manufacturers of the United States—Secy., George F. Boudinot, 30 Church St., New York City. Pres., George Pope. Annual meeting in May. Number of members: 4000.

National Association of Marine Engineers of Canada—Secy., Neil J. Morrison, P. O. Box 238, St. John, N. B. Pres., L. B. Cronk. Annual meeting in January. Number of members: 1200.

National Association of Master Gravel and Slag Roofers of America—Secy., H. B. Nichols, 1301 Whitehall Bldg., New York City. Pres., Lee H. Gould. Annual meeting in January. Number of members: 134.

National Association of Railway Commissioners—Secy., William H. Connolly, 1319 Columbia Road, Washington, D. C. Pres., Clifford Thorne. Annual meeting in October. Number of members: 250.

National Association of State and Municipal Boiler Inspection Departments—Secy., Robert U. Wolfe, Omaha, Neb. Annual meeting in August.

National Association of Stationary Engineers—Secy., Fred. W. Raven, 417 South Dearborn St., Chicago, Ill. Pres., Frederick L. Ray. Annual meeting in September. Number of members: 22,118.

National Brick Manufacturers' Association—Secy., Theodore A. Randall, 211 Hudson St., Indianapolis, Ind. Pres., C. P. Mayer. Annual meeting in February. Number of members: 700.

National Commercial Gas Association—Secy., Louis Stotz, 61 Broadway, New York City. Pres., H. B. McLean. Annual meeting in December. Number of members: 3000.

National Conference on Concrete Road Building—Secy., J. A. Beck, 208 South La Salle St., Chicago, Ill. Next conference, February, 1916. Attendance last conference: 595.

National Conservation Congress—Secy., Thomas R. Shipp, 711 Riggs Bldg., Washington, D. C. Pres., E. Lee Worsham. Annual meeting in November. Number of members: Delegate Body.

National District Heating Association—Secy., D. L. Gaskill, Greenville, Ohio. Annual meeting in June. Number of members: 340.

National Drainage Congress—Pres., Col. E. J. Watson, Columbia, S. C. Annual meeting in April.

National Electrical Contractors' Association—Secy., Geoorge H. Duffield, 41 Martin Bldg., Utica, N. Y. Pres., John R. Galloway. Annual meeting in July. Number of members: 1200.

National Electric Light Association—Secy., T. C. Martin, 29 West 39th St., New York City. Pres., Holton H. Scott. Annual meeting in June. Number of members: 12,000.

National Fire Protection Association—Secy., Franklin H. Wentworth, 87 Milk St., Boston, Mass. Pres., Robert D. Kohn. Annual meeting in May. Number of members: 2788.

National Gas Engine Association—Secy., H. R. Brate, Lakemont, N. Y. Pres., R. A. Oglesby. Annual meeting in June. Number of members: 250.

National Highways Association—Secy., F. R. Hutton, 18 Old Slip, New York City. Pres., Charles H. Davis.

National Lime Manufacturers' Association—Secy., Fred K. Irvine, 537 South Dearborn St., Chicago, Ill. Pres., W. E. Carson. Annual meeting in February. Number of members: 95.

National Machine Tool Builders' Association—Gen. Mgr., Chas. E. Hildreth, Worcester, Mass. Pres., W. A. Viall. Annual meeting in October. Number of members: 160.

National Municipal League—Secy., Clinton Rogers Woodruff, 703 North American Bldg., Philadelphia, Penn. Pres., William D. Foulke. Annual meeting in November. Number of members: 2600.

National Paving Brick Manufacturers' Association—Secy., Will P. Blair, 824 Brotherhood of Locomotive Engineers' Bldg., Cleveland, Ohio. Pres., Charles J. Deckman. Number of members: 60.

National Railway Appliances Association—Secy., Bruce V. Crandell, 1824 Lytton Bldg., Chicago, Ill. Pres., Norman M. Hench. Annual meeting in March. Number of members: 1500.

National Rivers and Harbors Congress—Secy., S. A. Thompson, 824 Colorado Bldg., Washington, D. C. Pres., J. E. Ransdell.

National Society for the Promotion of Industrial Education—Secy., C. A. Prosser, 140 West 42nd St., New York City. Pres., Hon. William C. Redfield.

Railway Development Association—Secy., H. O. Hartzell, Asst. Gen. Industrial Agent, B. & O. R.R., Baltimore, Md. Pres., F. H. LaBaume. Semiannual meetings in May and November. Number of members: 175.

Railway Electric Supply Manufacturers' Association—Secy., J. Scribner, care General Electric Co., Chicago, Ill. Pres., W. F. Bauer. Annual meeting in October. Number of members: 47 companies.

Railway Fire Protection Association—Secy., C. B. Edwards, Gulf Terminal Station, Mobile & Ohio R.R., Mobile, Ala. Pres., F. H. Elmore. Annual meeting in October. Number of members: 60.

Railway Gardening Association—Secy., W. F. Hutchison, Sewickley, Penn. Pres., Paul Huebner. Annual meeting in August.

Railway Materials Association—Secy., G. P. Gowing, 320 West 26th St., Chicago, Ill. Pres., C. B. Yardley. Annual meeting in May.

Railway Signal Association—Secy., C. C. Rosenberg, Times Bldg., Bethlehem, Penn. Pres., Thomas S. Stevens. Annual meeting in September. Number of members: 1250.

Railway Storekeepers' Association—Secy., J. P. Murphy, Box C., Collinwood, Ohio. Pres., G. G. Allen. Annual meeting in May. Number of members: 700.

Railway Supply Manufacturers' Association—Secy., J. D. Conway, 2136 Oliver Bldg., Pittsburgh, Penn. Pres., J. W. Johnson. Annual meeting in June. Number of members: 5000.

Roadmasters' and Maintenance of Way Association of America—Secy., L. C. Ryan, C. & N. W. Ry., Sterling, Ill. Pres., T. F. Donahoe. Annual meeting in September.

Sand-Lime Brick Association—Secy., H. W. Terry, care Harbor Brick Co., Toronto, Ont. Pres., W. H. Crume. Annual meeting in December.

Seismological Society of America—Secy., S. D. Townley, Stanford University, Calif. Pres., George D. Louderback. Annual meeting in April. Number of members: 360.

Signal Appliance Association—Secy., F. W. Edmunds, West Nyack, N. Y. Pres., L. Thomas. Annual meeting in September. Number of members: 100 (representatives of manufacturing concerns).

Society of American Bacteriologists—Secy., Dr. A. Parker Hitchens, Glenolden, Penn. Pres., Prof. D. H. Bergey. Annual meeting in December. Number of members: 270.

Society of Automobile Engineers—Secy., Coker F. Clarkson, 1786 Broadway, New York City. Pres., W. H. VanDervoort. Annual meeting in June. Number of members: 1550.

Society of Chemical Industry—Secy., Parker McIlhiney, 7 East 42nd St., New York City. Pres., Prof. G. G. Henderson. Annual meeting in July.

Society of Constructors of Federal Buildings—Secy., Charles R. Marsh, New Post Office Bldg., Plymouth, Mass. Pres., Maj. Charles F. Cramer. Annual meeting in January. Number of members: 150.

Society for Electrical Development, Inc.—Secy., James Smieton, Jr., 29 West 39th St., New York City. Pres., H. L. Doherty. Annual meeting in May. Number of members: 1223.

Society of Naval Architects and Marine Engineers—Secy., Daniel H. Cox, 29 West 39th St., New York City. Pres., Col. Robert M. Thompson. Annual meeting in November. Number of members: 800.

Society for the Promotion of Engineering Education—Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh, Penn. Pres., Anson Marston. Annual meeting in June. Number of members: 1400.

Society of Railway Club Secretaries—Secy., Harry D. Vought, 95 Liberty St., New York City. Pres., J. B. Anderson. Annual meeting in June.

Society of Technical Association Secretaries—Secy., Bradley Stoughton, 29 West 39th St., New York City. Pres., Harry D. Vought. Annual meeting in February. Number of members: 21.

Technical League of America—Secy., A. Buschman, 74 Cortlandt St., New York City. Pres., Prof. Charles W. Welch. Annual meeting in October. Number of members: 700.

Technical Publicity Association—Secy., Charles A. Hirschberg, Ingersoll-Rand Co., 11 Broadway, New York City. Pres., F. R. Davis. Number of members: 75.

Track Supply Association—Secy., W. C. Kidd, Ramapo Iron Works, Hillburn, N. Y. Pres., E. M. Fisher. Annual meeting in September. Number of members: 66 Supply Firms.

Train Dispatchers' Association of America—Secy., John F. Mackie, 7122 Stewart Ave., Chicago, Ill. Pres., C. A. O'Connor. Annual meeting in June. Number of members: 1078.

Traveling Engineers' Association—Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y. Pres., J. C. Petty. Annual meeting in September. Number of members: 1100.

Water Works Manufacturers' Association—Secy., E. K. Sorenson, 15 Broad St., New York City. Pres., Oscar B. Mueller. Annual meeting in May. Number of members: 90.

STATE AND DISTRICT SOCIETIES

Alabama Association of Highway Engineers—Secy., J. B. Converse, City Engineer, Selma, Ala. Pres., G. N. Mitcham. Annual meeting in January. Number of members: 43.

Alabama Society of Civil Engineers—Secy., S. J. Cumming, Gadsden, Ala. Pres., R. P. Boyd.

Appalachian Engineering Association—Secy., Dr. Henry M. Payne, Box 1833, General Post Office, New York City. Pres., Dr. E. A. Schubert. Annual meeting in February. Number of members: 67.

Arkansas Association of Surveyors and Civil Engineers—Secy., J. O. Jones, Birta, Ark. Pres., F. O. Cook. Annual meeting in December. Number of members: 80.

Arkansas Engineering Society—Secy., William J. Parkes, 203 Citizens Bank Bldg., Pine Bluff, Ark. Pres., J. J. Knoch. Annual meeting in January. Number of members: 43.

Arkansas Good Roads and Drainage Association—Secy., George R. Brown, Little Rock, Ark. Pres., E. P. Molitor. Annual meeting in January.

Association of Ontario Land Surveyors—Secy., L. V. Rorke, Surveys Branch, Parliament Bldgs., Toronto, Ont. Pres., James W. Fitzgerald. Annual meeting in February. Number of members: 362.

Canadian Railway Club—Secy., James Powell, Grand Trunk Ry., P. O. Box 7, St. Lambert, Que.

Central Electric Railway Association—Secy., A. L. Neeveamer, 308 Traction Terminal Bldg., Indianapolis, Ind. Pres., E. T. Schneider. Annual meeting in February. Number of members: 68 electric railway companies.

Central Railway Club—Secy., Harry D. Vought, 95 Liberty St., New York City. Pres., H. C. Manchester. Annual meeting in January. Number of members: 800.

Central States Water Works Association—Secy., R. P. Bricker, Shelby, Ohio. Pres., F. W. Collins. Annual meeting in May. Number of members: 150.

Colorado Electric Light, Power and Railway Association—Secy., T. F. Kennedy, 900 15th St., Denver Colo. Pres., W. C. Stearns.

Colorado Scientific Society—Secy., H. C. Parmelee. Pres., E. N. Hawkins. Annual meeting in December. Number of members: 225.

Connecticut Society of Civil Engineers—Secy., J. Frederick Jackson, Chamber of Commerce Bldg., New Haven, Conn. Pres., Charles C. Elwell. Annual meeting in February. Number of members: 350.

Electrical Contractors' Association of New York State—Secy., George W. Russell, Jr., 444 Columbus Ave., New York City. Pres., Lewis H. Wood. Annual meeting in January. Number of members: 100.

Engineering Association of the South—Secy., W. Harwell Allen, 928 Stahlman Bldg., Nashville, Tenn. Pres., Charles S. Brown. Annual meeting in December. Number of members: 200.

Engineering Society of Wisconsin—Secy., Prof. Leonard S. Smith, Madison, Wis. Pres., George Randall. Annual meeting in February. Number of members: 200.

Engineers' and Architects' Association of Southern California—Secy., Henry Z. Osborne, Jr., City Engineer's Office, Los Angeles, Calif. Pres., Samuel Storrow. Annual meeting in January. Number of members: 294.

Engineers' Society of Northeastern Pennsylvania—Secy., Thomas F. McKenna, 415 Washington Ave., Scranton, Penn. Pres., Charles Enzian. Annual meeting in January. Number of members: 475.

Engineers' Society of Pennsylvania—Secy., Edward R. Dasher, 31 South Front St., Harrisburg, Penn. Pres., Farley Gannett. Annual meeting in January. Number of members: 760.

Engineers' Society of Western New York—Secy., Elwin G. Speyer, 801 Chamber of Commerce, Buffalo, N. Y. Pres., Harry B. Alverson. Annual meeting in January. Number of members: 35.

Engineers' Society of Western Pennsylvania—Secy., Elmer K. Hiles, 2511 Oliver Bldg., Pittsburgh, Penn. Pres., Arnold Stucki. Annual meeting in January. Number of members: 1150.

Franklin Institute of the State of Pennsylvania—Secy., R. B. Owens, the Franklin Institute, Philadelphia, Penn. Pres., Dr. Walton Clark. Annual meeting in January. Number of members: 1365.

Highway Engineers' Association of Missouri—Secy., E. W. Sheets, Palmyra, Mo. Pres., E. F. C. Harding. Number of members: 44.

Idaho Society of Engineers—Secy., Ira F. Shaffner, P. O. Box 1133, Boise, Idaho. Pres., Barry Dibble. Annual meeting in January. Number of members: 132.

Illinois Association of County Superintendents—Secy., Walter E. Emery, Peoria, Ill. Pres., R. W. Osborn. Organized in 1915.

Illinois Gas Association—Secy., Horace H. Clark, Room 1327, 72 West Adams St., Chicago, Ill. Pres., L. H. Johnson. Annual meeting in March. Number of members: 400.

Illinois Society of Engineers and Surveyors—Secy., E. E. R. Tratman, Wheaton, Ill. Pres., W. S. Shields. Annual meeting in January. Number of members: 240.

Illinois Water Supply Association—Secy., Edward Bartow, University of Illinois, Urbana, Ill. Pres., H. M. Ely. Annual meeting in March. Number of members: 300.

Indiana Engineering Society—Secy., Chardles Brossmann, 1616 Merchants Bank Bldg., Indianapolis, Ind. Pres., E. H. Ahara. Annual meeting in January. Number of members: 300.

Indiana Sanitary and Water Supply Association—Secy., Dr. William F. King, 24 State House, Indianapolis, Ind. Pres., Dr. J. N. Hurty. Annual meeting in February. Number of members: 225.

Intermountain Good Roads Association—Secy., T. H. Burton, Nephi, Utah. Pres., L. Peters. Annual meeting in July.

Iowa Association of Cement Users—Secy., George P. Dieckmann, Mason City, Iowa. Pres., J. B. Marsh. Annual meeting in February. Number of members: 150.

Iowa Engineering Society—Secy., J. H. Dunlap, 104 N., Hall of Engineering, State University of Iowa, Iowa City, Iowa. Pres., William G. Raymond. Annual meeting in February. Number of members: 140.

Iowa Section, National Electric Light Association—Secy., W. H. Thomson, Jr., care Des Moines Electric Co., Des Moines, Iowa. Pres., H. B. Maynard. Annual meeting in April.

Iowa State Drainage Association—Secy., M. F. P. Costelloe, Ames, Iowa. Pres., H. M. Sparboe. Annual meeting in February.

Iowa Street and Interurban Railway Association—Secy., H. E. Weeks, Tri-City Railway & Light Co., Davenport, Iowa. Pres., R. A. Lessler. Annual meeting in April. Number of members: 21.

Kansas Engineering Society—Secy., C. A. Forter, City Hall, Topeka, Kan. Pres., T. J. Strickler. Annual meeting in January. Number of members: 133.

Kansas Gas, Water and Electric Association—Secy., E. A. Wright, Manhattan, Kan. Pres., W. A. McGruder. Annual meeting in September. Number of members: 126.

Kansas State Good Roads Association—Secy., G. J. Hinshaw, Kansas City, Kan. Pres., Mit Wilhite. Annual meeting in November. Number of members: 200.

Lake Michigan Water Commission—Secy., Edward Bartow, University of Illinois, Urbana, Ill. Pres., Dr. G. B. Young. Annual meeting in December. Number of members: 14.

Lake Superior Mining Institute—Secy., A. J. Yungbluth, Ishpeming, Mich. Pres., L. M. Hardenburgh. Annual meeting in August. Number of members: 600.

Louisiana Engineering Society—Secy., W. T. Hogg, P. O. Station 20, New Orleans, La. Pres., L. C. Datz. Annual meeting in January. Number of members: 204.

Maine Society of Civil Engineers—Secy., Frank E. Pressey, 487 Union St., Bangor, Maine. Pres., E. E. Greenwood. Annual meeting in February. Number of members: 189.

Michigan Engineering Society—Secy., Alba L. Holmes, 574 Wealthy Ave., Grand Rapids, Mich. Annual meeting in January.

Michigan Gas Association—Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich. Pres., John T. Young. Annual meeting in September. Number of members: 300.

Minnesota Surveyors' and Engineers' Society—Secy., George H. Herrold, Room 78, City Hall, St. Paul, Minn. Pres., W. H. Hoyt. Annual meeting in February. Number of members: 137.

Montana Institute of Municipal Engineers—Secy., Carl C. Widener, City Hall, Bozeman, Mont. Pres., C. E. Durland. Annual meeting in January. Number of members: 22.

Montana Society of Engineers—Secy., Clinton H. Moore, Box 355, Butte, Mont. Pres., Reno H. Sales. Annual meeting in April. Number of members: 175.

Nebraska Electrical Association—Secy., S. J. Bell, David City, Neb. Pres., H. A. Holdredge. Number of members: 30.

New England Association of Gas Engineers—Secy., N. W. Gifford, 26 Central Square, Boston, Mass. Pres., C. A. Learned. Annual meeting in February.

New England Railroad Club—Secy., W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Pres., H. Eastley. Annual meeting in March. Number of members: 700.

New England Water Works Association—Secy., Willard Kent, Narragansett Pier, R. I. Pres., Leonard Metcalf. Annual meeting in January. Number of members: 847.

New Jersey Sanitary Association—Secy., Dr. Edward Guion, 34 South North Carolina Ave., Atlantic City, N. J. Pres., Clyde Potts. Annual meeting in December. Number of members: 350.

New Jersey State Association of County Engineers—Secy., Garwood Ferguson, Court House, Paterson, N. J. Pres., Ralph D. Earle, Jr. Annual meeting in January. Number of members: 21.

New York Railroad Club—Secy., Harry D. Vought, 95 Liberty St., New York City. Pres., Frederick C. Syze. Annual meeting in November. Number of members: 2350.

New York State Electrical Contractors' Association—Secy., George W. Russell, 25 West 42nd St., New York City.

New York State Waterways Association—Secy., S. E. Ellsworth, 5 South Water St., Rochester, N. Y.

North Dakota Society of Engineers—Secy., E. F. Chandler, University of North Dakota, University, N. D. Pres., T. R. Atkinson. Annual meeting in February. Number of members: 60.

Northwestern Cement Products Association—Secy., J. C. Van Doorn, 836 Security Bank Bldg., Minneapolis, Minn. Pres., W. S. Kingsley. Number of members: 35.

Northwestern Electrical Association—Secy., John S. Allen, Lake Geneva, Wis.

Northwestern Road Congress—Secy., J. P. Keenan, Citizens' Business League, Milwaukee, Wis. Pres., J. W. Cooley. Annual meeting in October. Number of members: 500.

Nova Scotia Society of Engineers—Secy., D. McD. Campbell, Room 2, Davidson Bldg., Halifax, N. S. Pres., W. A. Hendry. Annual meeting in December. Number of members: 211.

Ohio Association of Contractors—Secy., A. J. Thatcher, 400 New First National Bank Bldg., Columbus, Ohio. Pres., N. B. Abbott.

Ohio Electric Light Association—Secy., D. L. Gaskill, Greenville, Ohio. Pres., C. V. Hood. Annual meeting in July. Number of members: 223.

Ohio Engineering Society—Secy., John Laylin, 712 Hartman Bldg., Columbus, Ohio. Pres., William F. Scheflen. Annual meeting in January. Number of members: 250.

Ohio Society of Mechanical, Electrical and Steam Engineers—Secy., Frank E. Sanborn, Ohio State University, Columbus, Ohio. Pres., William C. McCracken. Annual meeting in November. Number of members: 300.

Ohio Water Works Association—Secy., F. C. Jeannot, Marysville Light & Water Co., Marysville, Ohio. Annual meeting in February.

Oklahoma Civil Engineering Society—Secy., W. E. Moore, Oklahoma City, Okla. Annual meeting in January.

Oklahoma Society of Engineers—Secy., H. V. Hinckley, 1018 North Harvey St., Oklahoma City, Okla. Pres., S. A. Joyner. Annual meeting in December. Number of members: 53.

Oregon Society of Engineers—Secy., Orrin E. Stanley, Box 973, Portland, Ore. Pres., William S. Turner. Annual meeting in February. Number of members: 250.

Pacific Association of Consulting Engineers—Secy., Charles Derleth, Jr., University of California, Berkeley, Calif. Pres., Luther Wagoner. Annual meeting in September. Number of members: 28.

Pacific Coast Gas Association—Secy., Henry Bostwick, 445 Sutter St., San Francisco, Calif. Pres., E. C. Jones. Annual meeting in September. Number of members: 380.

Pacific Northwest Society of Engineers—Secy., Jesse A. Jackson, 312 Central Bldg., Seattle, Wash. Pres., Marvin Chase. Annual meeting in January. Number of members: 220.

Pennsylvania Water Works Association—Secy., W. C. Hawley, Wood St., Wilkinsburg, Penn.

Philippine Society of Engineers—Secy., R. T. Scholes, P. O. Box 322, Manila, P. I. Pres., E. R. Frisby. Annual meeting in January. Number of members: 63.

Railway Club of Pittsburgh—Secy., J. B. Anderson, 207 Pennsylvania Station, Pittsburgh, Penn. Pres., F. M. McNulty. Annual meeting in October. Number of members: 1050.

Richmond Railroad Club—Secy., F. O. Robinson, 606 Barton Ave., Richmond, Va. Pres., W. D. Duke. Annual meeting in November. Number of members: 350.

Railroad Club of Kansas City—Secy., Claude Manlove, 1008 Walnut St., Kansas City, Mo. Pres., Augustus A. Poland.

St. Louis Railway Club—Secy., B. W. Frauenthal, Union Station, St. Louis, Mo. Pres., A. L. Pollard. Number of members: 1200.

Sanitary Officers of the State of New York—Secy., Hills Cole, Albany, N. Y. Annual meeting in December.

Society of Engineers of Eastern New York—Secy., W. W. Griffiths, 29 Menands Rd., Albany, N. Y. Pres., F. C. Crane. Annual meeting in April. Number of members: 412.

Society of Engineers of North Central Washington—Secy., W. C. Muldrew, Okanogan City, Wash.

South Dakota Society of Engineers and Surveyors—Secy., R. B. Easton, Aberdeen, S. D. Pres., B. E. Lovejoy. Annual meeting in January. Number of members: 40.

Southern Gas Association—Secy., E. D. Brewer, 45 Poplar Circle, Atlanta, Ga. Pres., S. E. De Frese. Annual meeting in June. Number of members: 260.

Southern Supply and Machinery Dealers' Association—Secy., Alvin M. Smith, Box 71, Richmond, Va. Pres., John A. Harwin. Annual meeting in April. Number of members: 94.

Southern and Southwestern Railway Club—Secy., A. J. Merrill, Box 1205, Atlanta, Ga. Pres., George Akans. Annual meeting in November. Number of members: 450.

Southwestern Electrical and Gas Association—Secy., H. S. Cooper, 405 Slaughter Bldg., Dallas, Tex. Pres., G. H. Clifford. Annual meeting in May. Number of members: 300.

Southwestern Water Works Association—Secy., E. L. Fulkerson, Waco, Tex. Pres., H. L. McDuffie. Annual meeting in June. Number of members: 200.

Technical Society of the Pacific Coast—Secy., Otto Von Geldern, 865 Pacific Bldg., San Francisco, Calif. Pres., Prof. H. Kower. Annual meeting in January. Number of members: 150.

Tri-State Water and Light Association of the Carolinas and Georgia—Secy., J. G. Barnwell, Rock Hill, N. C. Pres., F. C. Wyse. Annual meeting in April. Number of members: 114.

Utah Society of Engineers—Secy., Frank W. Moore, 1111-2 Newhouse Bldg., Salt Lake City, Utah. Pres., Sylvester Q. Cannon. Annual meeting in April. Number of members: 152.

Vermont Electrical Association—Secy., C. H. West, Rutland, Vt. Pres., W. H. Vorce.

Vermont Society of Engineers—Secy., G. A. Reed, Barre, Vt. Pres., A. C. Grover. Annual meeting in March. Number of members: 102.

Washington Irrigation Institute—Secy., L. L. Lynn, Prosser, Wash. Pres., E. F. Benson.

Western Canada Railway Club—Secy., Louis Kon, P. O. Box 1707, Winnipeg, Man. Pres., A. H. Eager. Annual meeting in May. Number of members: 528.

Western Paving Brick Manufacturers' Association—Secy., G. W. Thurston, 416 Dwight Bldg., Kansas City, Mo. Pres., Robert Nasch. Annual meeting in January. Number of members: 10.

Western Railway Club—Secy., Joseph W. Taylor, 1112 Karpen Bldg., Chicago, Ill. Pres., E. W. Pratt. Annual meeting in May. Number of members: 1500.

Western Society of Engineers—Secy., J. H. Warder, 1735 Monadnock Block, Chicago, Ill. Pres., William B. Jackson. Annual meeting in January. Number of members: 1189.

Wisconsin Electrical Association—Secy., George Allison, First National Bank Bldg., Milwaukee, Wis. Pres., M. C. Ewing. Annual meeting in January. Number of members: 150.

Wisconsin Gas Association—Secy., Henry Harman, 182 Wisconsin St., Milwaukee, Wis. Pres., James H. Walker. Number of members: 190.

Wisconsin Highway Commissioners' Association—Secy., G. H. Mainwaring, Gotham, Wis. Pres., H. J. Kuelling. Annual meeting in February. Number of members: 157.

Wyoming Society of Civil Engineers—Secy., M. N. Woolery, Thermopoli, Wyo.

LOCAL SOCIETIES

Affiliated Technical Societies of the City of Atlanta—Secy., Park A. Dallas, 913 Chandler Bldg., Atlanta, Ga. Chairman, A. M. Schoen.

Albany Society of Civil Engineers—Secy., Ernest G. Raynor, Barge Canal Office, Albany, N. Y. Pres., C. C. Covert. Annual meeting in January. Number of members: 205.

Architectural League of New York—Secy., Owen Brainard, 215 West 57th St., New York City. Pres., Cass Gilbert. Annual meeting in May. Number of members: 550.

Associated Engineering Societies of St. Louis—Secy., Joseph W. Peters, 3817 Olive St., St. Louis, Mo. Chairman, John W. Woermann. Annual meeting in December. Number of members: 750.

Boston Architectural Club—Secy., Ralph W. Gray, 8 Beacon St., Boston, Mass. Pres., Louis C. Newhall. Annual meeting in October. Number of members: 400.

Boston Scientific Society—Secy., Nelson C. Davis, M. D., 494 Rutherford Ave., Charlestown, Mass. Pres., J. Ritchie, Jr. Annual meeting in April. Number of members: 75.

Boston Society of Architects—Secy., Charles U. Cogswell, Old South Bldg., Boston, Mass. Annual meeting in January. Number of members: 240.

Boston Society of Civil Engineers—Secy., S. Everett Tinkham, 715 Tremont Temple, Boston, Mass. Pres., Charles R. Gow. Annual meeting in March. Number of members: 867.

Brooklyn Engineers' Club—Secy., Joseph Strachan, 117 Remsen St., Brooklyn, N. Y. Pres., Jacob S. Langthorn. Annual meeting in December. Number of members: 400.

Chemists' Club—Secy., Reston Stevenson, 52 East 41st St., New York City. Pres., Prof. Milton C. Whitaker. Annual meeting in December. Number of members: 1227.

Chicago Electric Club—Secy., F. S. Hickok, 824 Marquette Bldg., Chicago, Ill. Pres., W. R. Pinckard.

Chicago Engineers' Club—Secy., C. H. Norwood, 417 South Dearborn St., Chicago, Ill. Pres., Edward Haupt. Annual meeting in March. Number of members: 400.

Chicago Technical League—Secy., Louis A. Heyn, 32 North Fifth St., Chicago, Ill. Pres., C. O. Johnson.

Cincinnati Engineers' Club—Secy., E. A. Gast, P. O. Box 333, Cincinnati, Ohio. Pres., J. T. Faig. Annual meeting in December. Number of members: 300.

Cleveland Engineering Society—Secy., David Gaehr, 413 Chamber of Commerce Bldg., Cleveland, Ohio. Pres., Elliott H. Whitlock. Annual meeting in June. Number of members: 800.

Des Moines Engineers' Club—Secy., H. W. Hartupee, 1260 34th St., Des Moines, Iowa. Pres., J. E. Van Llew. Annual meeting in June. Number of members: 50.

Detroit Engineering Society—Secy., Frederick H. Mason, 614 Moffatt Bldg., Detroit, Mich. Pres., H. H. Esselstyn. Annual meeting in April. Number of members: 600.

Engineering Society of Buffalo—Secy., John Younger, 25 Horton Place, Buffalo, N. Y. Pres., David Bell. Annual meeting in May. Number of members: 300.

Engineers' and Architects' Club of Louisville, Inc.—Secy., Pierce Butler, 1412 Starks Bldg., Louisville, Ky. Pres., Malcolm Elliott. Annual meeting in January. Number of members: 226.

Engineers' Club of Baltimore—Secy., William D. Janney, 6 West Eager St., Baltimore, Md. Pres., Francis Lee Stuart. Annual meeting in June. Number of members: 290.

Engineers' Club of Dayton—Secy., Donald A. Kohr, 36 Oxford Ave., Dayton, Ohio. Pres., E. A. Deeds. Annual meeting in June. Number of members: 125.

Engineers' Club of Kansas City—Secy., E. B. Murray, 920 Walnut St., Kansas City, Mo. Pres., J. W. Malcolmson.

Engineers' Club of Memphis—Secy., C. C. Pashby, City Hall, Memphis, Tenn. Pres., J. H. Weatherford. Annual meeting in February.

Engineers' Club of Minneapolis—Secy., E. W. Ashenden, 17 East Seventh St., Minneapolis, Minn. Pres., George L. Wilson. Annual meeting in January. Number of members: 75.

Engineers' Club of Philadelphia—Secy., Lewis H. Kenney, 1317 Spruce St., Philadelphia, Penn. Pres., J. W. Ledoux. Annual meeting in February. Number of members: 599.

Engineers' Club of St. Louis—Secy., S. W. Bowen, 3817 Olive St., St. Louis, Mo. Pres., John W. Woermann. Annual meeting in December. Number of members: 450.

Engineers' Club of Toronto—Secy., R. B. Wilsey, 90 King St., West, Toronto, Ont. Annual meeting in February. Number of members: 445.

Engineers' Club of Trenton—Secy., Joseph E. English, P. O. Box 549, Trenton, N. J. Pres., Alfred C. Gregory. Annual meeting in December. Number of members: 240.

Engineers' Society of St. Paul—Secy., Edward J. Dugan, P. O. Box 654, St. Paul, Minn.

Engineers' Society of San Antonio—Secy., J. H. Lockridge, San Antonio, Tex. Pres., W. B. Tuttle.

Master Builders' Association of Boston—Secy., W. H. Sayward, 166 Devonshire St., Boston, Mass. Pres., D. Bradford Badger.

Municipal Engineers of the City of New York—Secy., George A. Taber, 29 West 39th St., New York City. Pres., Amos Schaeffer. Annual meeting in January. Number of members: 534.

New York Electrical Society—Secy., George H. Guy, 29 West 39th St., New York City. Pres., Frederick A. Scheffler. Annual meeting in June. Number of members: 762.

New York Society of Architects—Secy., William T. Towner, 38 Park Row, New York City. Pres., Constantine Schubert. Annual meeting in January. Number of members. 382.

Providence Association of Mechanical Engineers—Secy., J. Ansel Brooks, Brown University, Providence, R. I. Pres., William Howard Paine. Annual meeting in June. Number of members: 250.

Railroad Club of Kansas City—Secy., Claude Manlove, 1008 Walnut St., Kansas City, Mo. Pres., Augustus A. Poland.

Richmond Society of Engineers, Richmond, Va.—Secy., James Bolton. Pres., A. Scrivenor.

Rochester Engineering Society—Secy., William F. Devendorf, 350 East Ave., Rochester, N. Y. Pres., I. Lundgaard. Annual meeting in June. Number of members: 230.

St. Paul Civil Engineers' Society—Secy., C. E. Nagel, Room 7, Old Capitol Bldg., St. Paul, Minn. Pres., George W. Rathjens. Number of members: 167.

Society of Municipal Engineers of Philadelphia—Secy., H. W. Benjamin, 129 South 11th St., Philadelphia, Penn. Pres., William H. Connell. Annual meeting in June. Number of members: 450.

Swedish Engineers' Society of Chicago—Secy., G. A. Akerlind, 619 City Hall Square Bldg., Chicago, Ill. Pres., Albin P. Rissler.

Technology Club of New York—Secy., F. C. Schmitz, 17 Gramercy Park, New York City. Pres., Walter Large. Annual meeting in February. Number of members: 967.

Technology Club of Syracuse—Secy., Albert R. Acheson, 852 Ostrom Ave., Syracuse, N. Y. Pres., Charles L. Griffin. Annual meeting in May. Number of members: 273.

Technischer Verein, New York—Secy., Albert Weber, 54 11th St., Hoboken, N. J. Pres., George A. Sonderhof. Annual meeting in January. Number of members: 120.

Technischer Verein, Philadelphia—Secy., W. H. Friebel, 226 South Seventh St., Philadelphia, Penn. Pres., H. Schmaltz. Annual meeting in October. Number of members: 102.

Telephone Society of New York—Secy., R. S. Scarburgh, 15 Dey St., New York City. Pres., Dr. F. B. Jewett. Annual meeting in May. Number of members: 3071.

Washington Society of Engineers—Secy., John C. Hoyt, 1330 F St., N. W., Washington, D. C. Annual meeting in December. Number of members: 388.

Winona Association of Commerce, Inc.—Secy., James B. Kinsloe, 100 Exchange Bldg., Winona, Minn. Pres., J. R. McConnon. Annual meeting in February. Number of members: 656.

ENGINEERING SOCIETIES

COMING MEETINGS

NATIONAL DISTRICT HEATING ASSOCIATION.
June 1-3. Annual convention at Hotel Sherman, Chicago. Secy., B. L. Gaskill.

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.
June 3-4. Annual convention at Bellevue-Stratford, Philadelphia, Penn. Secy., F. D. Mitchell, 1510 Woolworth Bldg., New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 7-9. National Conference in Detroit, Mich. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 9-11. Annual convention in Atlantic City. Secy., Jos. M. Taylor, Karpen Bldg., Chicago.

MASTER CAR BUILDERS' ASSOCIATION.
June 14-16. Annual convention in Atlantic City. Secy., Jos. M. Taylor, Karpen Bldg., Chicago.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
June 17-18. Semi-annual meeting at Toledo. Secy., Frank E. Sanborn, Ohio State University, Columbus.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 22-25. Annual meeting at Iowa State College, Ames, Iowa. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh, Penn.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 22-25. Summer meeting at Buffalo, N. Y. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 22-26. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

American Electrochemical Society—The 28th general meeting of the society will be held in San Francisco, Sept. 16-18. Members are urged to notify the Secretary in regard to papers available for this meeting. Papers will be published in advance of the meeting, and their early distribution requires that they be received at headquarters not later than July 15. All inquiries as to transportation should be addressed to J. M. Muir, 239 West 39th St.

American Institute of Electrical Engineers—Authority was granted by the Board of Directors on May 18 for the organization of a section in Denver, Colo. This was in response to a petition of 28 Institute members in Denver.

The Technology Club of Syracuse—At the annual meeting of the Technology Club of Syracuse the following officers were elected: President, Prof. A. R. Acheson; first vice-president, Alexander Palmros; second vice-president, Edmund L. French; secretary, Ellis E. Lawton, 700 Vinney Building; treasurer, Marshall B. Palmer. The retiring president, Chas. L. Griffin, read a paper on "The Detail of Engineering Construction," which dealt with some of the problems entering into the construction of large boiler plants. The paper considered particularly the 2300-hp. boilers being installed by the Solvay Process Co.